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ABSTRACT

This document reports on state indicators for the quality of science and mathematics education in public schools and the trends in science and mathematics education as of 1999-2000, a system developed by the Council of Chief State School Officers (CSSO) in cooperation with the state departments of education, federal agencies, and professional organizations. The present report on trends in science and math education as of 2001 is the sixth in a series of biennial reports on state and national indicators intended for use by policymakers, educators, and researchers. Contents include: (1) "Development of State Education Indicators for Policymakers"; (2) "Indicators of Student Achievement in Mathematics and Science"; (3) "Indicators of Mathematics and Science Curriculum"; (4) "Indicators of Teacher Preparation and Supply"; and (5) "Indicators of Context and Conditions for Teaching"; (6) "Data Sources and Computations"; and (7) "Directory of State Course Titles by Reporting Categories." (Contains 67 references, 39 tables, and 10 figures.) (YDS)

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COUNCIL OF CHIEF STATE SCHOOL OFFICERS

STATE INDICATORS OF SCIENCE AND MATHEMATICS EDUCATION 2001

State-by-State Trends and New Indicators from the 1999–2000 School Year

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Rolf K. Blank
Doreen Langesen

The development of this report was supported by a grant from the National Science Foundation (REC-01-18355). Data for the report were obtained through the cooperation of the state departments of education and the National Center for Education Statistics at the U.S. Department of Education.

The Council of Chief State School Officers (CCSSO) is a nationwide, nonprofit organization of the public officials who head departments of elementary and secondary education in the states, the District of Columbia, the Department of Defense Education Activity, and five extra-state jurisdictions. CCSSO seeks its members' consensus on major education issues and expresses their view to civic and professional organizations, to federal agencies, to Congress, and to the public. Through its structure of standing and special committees, the Council responds to a broad range of concerns about education and provides leadership on major education issues.

The State Science and Mathematics Indicators were developed through collaboration of the Council's Indicators program with all of the state departments of education, the National Science Foundation, and the U.S. Department of Education. The indicators were selected and designed to provide valid, comparable state-by-state and national data on the condition of science and mathematics education in elementary and secondary schools. Data are reported every two years using a consistent set of indicators. The current report, *State Indicators of Science and Mathematics Education, 2001*, is based on data from the 1999–2000 school year.

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This report is the result of successful cooperation of the Council of Chief State School Officers with the state departments of education, the National Science Foundation (NSF), and the U.S. Department of Education. The State Science and Mathematics Indicators Report was initiated in 1986 as a result of the commitment of the National Science Foundation to improving the quality of information on science and mathematics education in the nation's schools. The Council's work in developing a system of state-level indicators of science and mathematics education is made possible by the collective decision of the state superintendents and commissioners to have valid, comparable state-by-state data to assess educational progress.

The Science and Mathematics Indicators Report receives strong support from each of the state superintendents and commissioners. State data managers, science and mathematics specialists, and assessment directors have willingly given their time, expertise, and assistance to the project. State education staff have played active roles in the selection of indicators and design of a data reporting system, and some indicators are based on data from state education information systems.

The Council very much appreciates the strong support by the National Science Foundation for development and continuation of the State Science and Mathematics Indicators. We particularly acknowledge Bernice Anderson and Larry Suter, program officers in the Division of Research, Evaluation, and Communication at NSF, who have provided important guidance and suggestions throughout development of the state indicators. The Assessment Division of the National Center for Education Statistics of the U.S. Department of Education provided state-by-state data for the NAEP Mathematics and Science Assessments. We very much appreciate the support and assistance of NCES.

The Council staff and the states have benefited greatly from the insightful recommendations and suggestions of expert advisors since the beginning of our work. State leaders, science and mathematics educators, researchers, and federal agency staff who advise us have ensured that the indicators are soundly based on research and that they provide important information for policy and program decisions.

Introduction

Development of State Education Indicators for Policymakers

In cooperation with the state departments of education, federal agencies, and professional organizations, the Council of Chief State School Officers (CCSSO) has developed a system of state indicators of the quality of science and mathematics education in public schools. The present report on trends in science and math education as of 2001 is the sixth in a series of biennial reports on state and national indicators. The reports are intended for use by policymakers, educators, and researchers.

The design, management, and reporting of indicators have been supported by the state departments of education and National Science Foundation (NSF) since the project was initiated in 1986. State education leaders make major contributions to the system through advice on selection of indicators, collecting and reporting data from schools, and disseminating the indicators within states. In selecting and reporting state indicators, we also consult with science and mathematics educators, statistical experts, and federal officials. The Council places high priority on advocating for improving the quality and comparability of assessments and data that can produce reliable indicators of the health of our elementary and secondary schools.

Rationale: Need for State Science and Mathematics Education Indicators

The science and mathematics indicators developed and reported by CCSSO and the states meet at least three different kinds of interests and needs:

- **Measure Progress:** Reliable, comparable indicators, by state, to assess progress toward national state goals
- **Analyze Policies:** A range of measures that are useful for analyzing the effects of state education policies and reform initiatives
- **Assess Needs and Plan:** Indicators, addressing the quality of science and mathematics instruction and teachers, that are useful to policymakers for evaluating programs, identifying problems, and recommending new initiatives.

Measure Progress. Efforts to develop a system of national and state indicators of the quality of science and mathematics education began in the mid-1980s. Widely read reports on the condition of elementary and secondary education, including *A Nation at Risk* (National Commission on Excellence in Education, 1983) and *Educating Americans for the 21st Century* (National Science Board, 1983), helped spur national and state reform initiatives; these reports also increased attention on improving the quality and availability of information to monitor progress and report on current conditions.

> ***"Reaching a new standard of excellence requires clear educational objectives, strong leadership and firm commitment at all levels. Goals must be set and press toward those goals assessed....The Federal government should finance and maintain a national mechanism for measuring student achievement and participation [in mathematics, science and technology education] in a manner that allows national, state and local evaluation and comparison of educational progress."***
>
> *Educating Americans for the 21st Century*

A central reason for national and state cooperation toward a system of comparable state-level education indicators is that states establish much of the legal and policy structure for education, as well as a majority of funds for K-12 education. State leaders recognize that major decisions about funding, program design, and moving toward standards requires high-quality information that is reliable, regularly reported, and readily available. Recent national commissions of experts and policymakers have renewed the call for better systems of data on the quality of teachers and teaching in science and mathematics education (National Commission on Teaching and America's Future, 1996; U.S. Department of Education, 2000).

Analyze Policies. In the 1980s, states initiated a broad set of education policy reforms, including increased course credit requirements for graduation (particularly in mathematics and science), higher standards for teacher preparation, teacher tests for certification, higher levels for teacher pay, state curriculum guidelines and frameworks, and new statewide student assessments (Blank & Dalkilic, 1992; Blank & Espenshade, 1988; National Governors' Association [NGA], 1986). An initial motivation for the Council's system of science and mathematics indicators was to track these policy changes over time and report statistical indicators to assist states in analyzing the relationship of policies and reforms to improvements in education quality. The National Education Goals, established in 1989, provided another incentive for state education indicators (NEGP, annual report, 2000).

States have placed a high priority on developing new state curriculum frameworks and standards for academic subjects that are the basis for state education improvements. National professional standards for mathematics and science education set by the National Council of Teachers of Mathematics (1989, 1991, 2001; American Association for Advancement of Science, 1993; National Research Council, 1995) were a key resource for many of the state curriculum frameworks and standards for student learning established in the 1990s (Blank, Pechman, et al., 1997; CCSSO). Now, almost all states have state-approved standards (CCSSO, 2000), which state education leaders will use as the basis for measuring extent of improvement in science and mathematics education.

Assess Needs and Plan. The state indicators are also aimed at assisting state leaders and others in identifying state and national trends, planning and evaluating programs, and working on new initiatives. For example, the CCSSO indicators provided comparable data for measuring change over time in course enrollments and professional development related to NSF's Statewide Systemic Initiatives (SSI) that operated in 25 states. Almost all states have annual accountability reports and profiles, which are used to track changes in learning as well as the conditions in schools and classrooms.

The CCSSO state science-math indicators system provides a model for state policymakers and researchers to use in selecting indicators and comparable data sources for their reports. All state education agencies administer the federally funded Eisenhower Science and Mathematics Program for teacher professional development, and the science-math state indicators can be instrumental in identifying the needs for improving teaching practices and improving the quality of the teaching force. Importantly, as policymakers consider programs to increase the supply of qualified teachers, the indicators provided in these reports offer statistics on the demographic characteristics of the teaching force by state, the rate of new teachers entering science and mathematics, and the current areas of teacher shortage, as well as the level of preparation of current teachers in their assigned fields.

The science and mathematics indicators have other practical applications. State administrators have used course enrollment data to analyze differences in the level of course-taking in their states, as compared with states in their region and states with similar demographic characteristics. Policymakers have been able to compare the proportion of science and mathematics teachers with a degree in their teaching field with recommended and proposed standards for teacher preparation. Educators have identified teacher shortages by science specialization and by gender and race to target teacher recruitment and professional development programs.

Model for Selecting Indicators

The indicators of science and math education for the states and nation were selected and developed using three main criteria:

- **Policy issues reflecting state needs.** Indicators should reflect the needs of users of education data, particularly policymakers and educators. CCSSO worked with reviewers with varying perspectives on initial formulation of the indicators, and obtains ongoing review and comment from policymakers, researchers, and educators.
- **Quality data based on reliability, validity, and comparability.** Indicators are selected to ensure that reliable comparable data are available at the state level. Managers of state data systems have continuing input into the system. Data reported on current indicators are continually evaluated.
- **Research-based model**. A research-based model of the education system was used to identify appropriate categories of system indicators, including state context, school curriculum, teacher preparation, teaching practices, and class conditions, as well as measures of student outcomes.

In the initial design of the science-math indicators system, CCSSO worked with an expert advisory panel to develop a conceptual framework that formed the basis for review and selection of a set of indicators. We evaluated existing studies in science-math education and reviews of research, and we surveyed states, to identify desired indicators and the availability of data by state (Murnane & Raizen, 1988; National Science Board, 1983, 1993; National Study Panel on Education Indicators, 1991; NGA, 1986; Oakes, 1986, 1989; Porter, 1991; Shavelson, McDonnell, & Oakes, 1987; Weiss, 1994). State indicators comparable across states and summarized for the nation were first reported in 1991 under six categories: student outcomes,

instructional time/participation, curriculum content, teacher quality, school conditions, and equity (Blank & Dalkilic, 1991).

Methods of Reporting and Using Data on Indicators

Basic decisions by CCSSO and expert advisors define the science-math indicators and how they are reported and displayed by state; readers will note the following characteristics of the report:

a) **Multiple indicators, but not composite score.** CCSSO emphasizes use of several indicators under each category in the model. Because the report is designed for multiple uses and audiences, indicators are each reported separately—thus providing users with the option of combining the data into a summary index or simply analyzing differences or trends for individual measures. In the CCSSO reports, the accumulated set of indicators is not reported in a summary "profile" for each state although this might be a useful approach for within-state needs assessment or evaluation (see "Use of Indicators" below).

b) **Graphics and tables highlight state trends, not rank among states.** Reporting which states are "ahead" or "behind" other states is not a main purpose of the indicators (CCSSO, 1985). We encourage analysis of trends for a given state and comparison with trends for similar states or states in the same region. In several figures with bar graphs, states are reported in rank order based on gains or change on the indicator. Second, this report provides no analysis of cause-and-effect relationships between indicators. The emphasis is on reporting variation and trends by state for individual indicators. We do provide references to analyses and research with these indicators that have been completed by others, and we encourage further analysis of the data presented here. The indicators were selected by using a model of the educational system that helps educators identify factors that explain improvement in educational outcomes. See Blank (1993) for further information and elaboration on the process of selecting and developing state education indicators.

c) **Goal of 50-state reporting.** Several sources of data were used to develop these indicators, including sample surveys, such as NAEP, and universe data, such as state information systems. Our data sources do not all provide complete, 50-state data on the indicators. Although our goal is to report for all states and the nation, many of the indicators have 30 to 40 states represented. When all states were not reported, national statistics were computed using imputation for missing state data (see Appendix). We encourage all states to participate in reporting and using state indicators that are comparable among states. However, this project is voluntary and requires states to devote time and resources.

Use of Indicators for Needs Assessment within States. The approach CCSSO has used in this report for science and mathematics indicators is appropriate for state-by-state analysis and reporting. Within a state, the same data and indicators would be used somewhat differently if state leaders were doing an assessment of needs for improving science and math, such as to prepare for considering new/revised policies or programs. We suggest the following kinds of data and analyses are needed for within-state needs assessments:

- *Identify a goal or benchmark for each indicator.* Our 50-state report does not employ goals or intermediate benchmarks to measure gains, but a state would want to have them in their own within-state indicator system. For example, a benchmark for improving teacher quality might be two percent gain in the percentage of teachers certified in their assigned field by a specific date, such as two years.
- *Disaggregate data.* State averages or percentages for the whole state are not particularly helpful within a state. Totals will need to be disaggregated by district, by school characteristics such as enrollment or location, or by teacher characteristics such as quality of preparation or years of experience.
- *Additional indicators.* The indicators in this report are selected to be comparable across states, and we have maintained a limited number of indicators over time. However, in any specific state, additional indicators could be added. For example, if the question involved assessing the state needs for improving the quality of teachers and teaching, a state would need to add to the indicators CCSSO used in this report (i.e., teacher major/minor, certification, teacher demographics, new teachers by state). The state would also want data on the following indicators: a) average teacher pay in science and math fields, b) turnover rate of teachers by school/district characteristics, c) average teacher experience by field and variation by school characteristics, or d) level and quality of professional development for new and experienced teachers. A good resource for building state models of indicators to examine teacher quality issues is the National Commission on Teaching & America's Future (1996; http://www.nctaf.org/).
- *Comparative vs. qualitative analysis.* One approach to developing a needs assessment focuses on **comparative** analysis of data among schools and districts and analysis of trends. This model emphasizes behavioral measures or demographic measures, with the goal to compute a composite index of the status of a given problem, such as the need for quality teachers and teaching. Data on a variety of indicators can be combined in a scale score or index that gives a quantified comparison across different locations, e.g., an index of need for higher quality teachers for each school district possibly grouped by total enrollment. A **qualitative** model for use of indicators in needs analysis emphasizes staff responses concerning issues, such as through a survey or on a questionnaire. For example, to address teacher quality, teachers and principals might answer questions about positions that are hard to fill, views on incentives/disincentives for working in their school, perceptions about conditions for teaching, quality of resources, or degree of "colleagueship" with teachers.

These are basic steps that a state should consider in planning a needs assessment study based on the science and math indicators. A number of other considerations can apply. CCSSO is interested in working with states on improving uses of data and indicators within states.

Sources of Data for Reporting

We used three primary sources of data to report the 1999 state science and mathematics indicators:

1. The National Assessment of Educational Progress (NAEP) assessments in mathematics and science, administered by the NCES, are used to report indicators of student

achievement by state, and teachers questionnaires were used for data on teaching practices in mathematics and professional development of teachers.

2. Results from the Advanced Placement examinations, administered by The College Board, also provide indicators of student achievement.
3. The Council collected aggregated data from state departments of education on indicators of course enrollment, teacher assignments and characteristics, teacher certification, and new teachers in math and science. The data were collected through state information systems, and reported to CCSSO using standard data categories.

   Note: The Schools and Staffing Survey (SASS) is a source for state-representative data on teacher preparation and school conditions for science and mathematics. The periodic Survey for teachers, schools, and districts is conducted by NCES. However, the most recent survey results for the 1999–2000 school year are not yet available. CCSSO will work with these data when they are available.

Organization of the Report

The state indicators are outlined in the next four chapters of the report. Chapter 1 describes indicators of student achievement in mathematics and science, with an emphasis on achievement by student race/ethnicity and gender. Chapter 2 includes indicators of curriculum, instructional practices, and class time, with a focus on their relation to state policies and professional standards. Chapter 3 provides state indicators of the quality of preparation of teachers and trends in the supply of teachers. Chapter 4 has several indicators of conditions in schools for science and mathematics teaching.

The report Appendices provide detailed data and information by state. Appendix A gives details on data sources and computations; and Appendix B provides a directory of course definitions and titles. The web-based version of the 2001 report contains detailed data by state on course enrollments and teachers from state information systems (http://www.ccsso.org/SciMathIndicators01.html).

Chapter One

Indicators of Student Achievement in Mathematics and Science

Student Proficiency on NAEP

Policy Issues:

*** Is student achievement in mathematics and science improving, and how does achievement compare state to state?**

*** Are students learning challenging content in science and mathematics?**

*** Are schools improving the performance of all students?**

CCSSO strongly supports the development and use of the state-level National Assessment of Educational Progress (NAEP) as a primary indicator of student learning in mathematics and science. The Council has an intensive record of involvement with the state-level NAEP. In the mid-1980s CCSSO as an organization became an advocate for comparable state-level indicators for K-12 education. For the 1990 NAEP mathematics assessment (which produced the first state-level results), CCSSO led the consensus planning process for writing the mathematics assessment framework. CCSSO also led the framework development for the 1996 NAEP science assessment, and currently we are preparing the mathematics framework for the 2004 NAEP. In the view of the Council, NAEP is the best source for student achievement indicators first because it provides reliable, comparable measures state to state. From the Council's involvement in developing the NAEP math and science frameworks, we are confident the assessments adequately address the range of content topics and expectations for learning that are recommended in state standards.

The NAEP assessment results, and supporting data on students, teachers, and schools, are based on a sample of 2,000 students per state at each assessed grade. The data do not provide a way for states to analyze student achievement for each school and district. The results, however, are still extremely valuable as indicators for state and local policymakers, subject specialists, and teachers. NAEP results at the state and national levels provide:

- Valid, reliable data to monitor and compare state progress in student achievement;
- Data to evaluate the quality of education received by specific groups of students;
- Trends for each state against a common set of challenging standards for student learning and performance;
- A comprehensive source of data to measure the relationship of student achievement to characteristics of schools, classroom practices, and teachers, by state.

The state-level NAEP results reported here are primarily drawn from reports of the National Center for Education Statistics of the U.S. Department of Education following the 2000 NAEP for Mathematics and Science (http://nces.ed.gov/nationsreportcard/; Mathematics: Braswell, et al., 2001; Science: Solomon, et al., 2001).[1]

[1] Earlier reports with NAEP math and science results for 1996 and earlier are: Mathematics (Reese, et al., 1997; Shaughnessy, et al., 1998); Science (Bourque, et al., 1997; Keiser, et al., 1998).

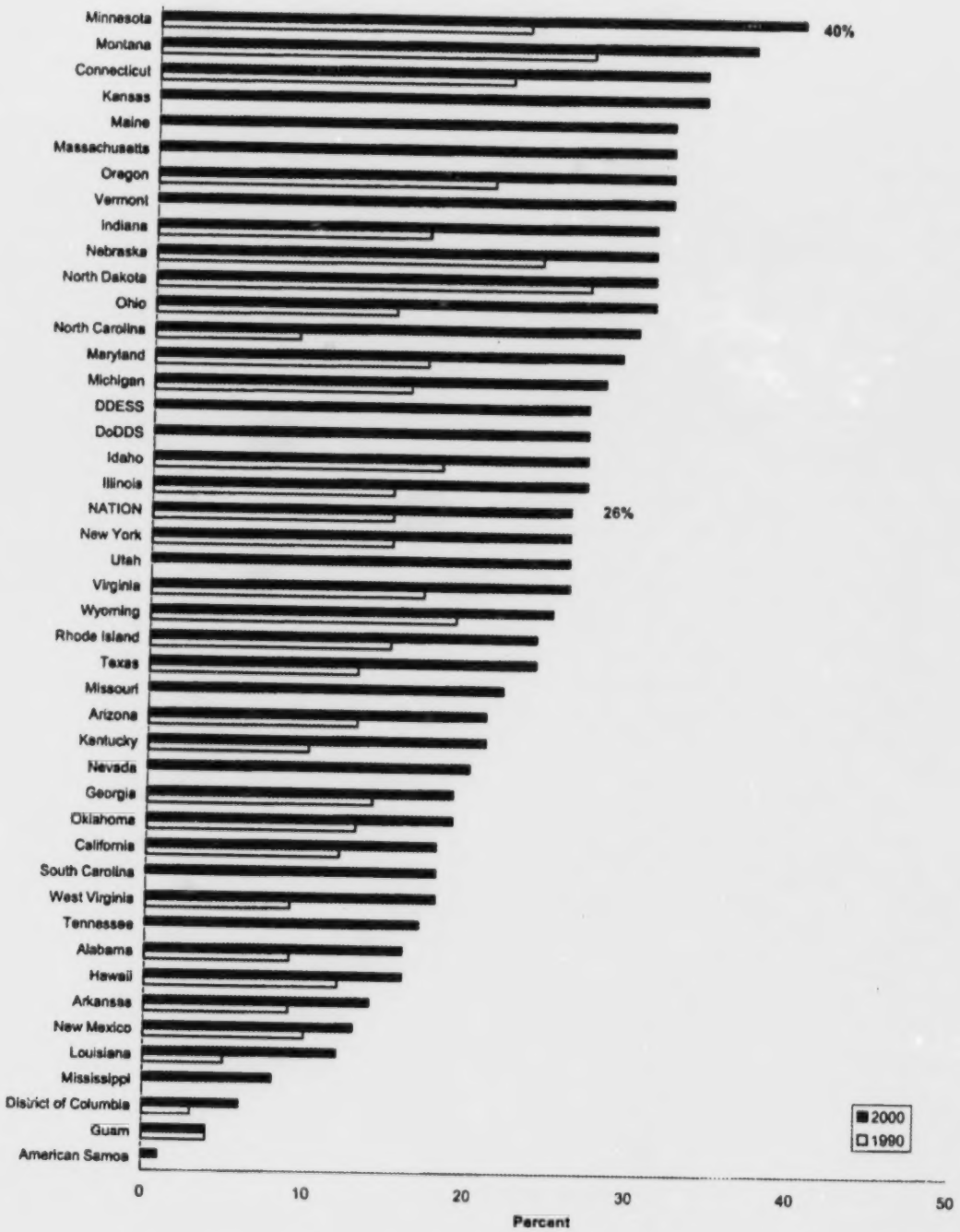
Improvement in Mathematics Proficiency of Grade 8 Students

- **From 1990 to 2000, half the states made significant improvement in the percentage of grade 8 students reaching the "Proficient" level on the National Assessment of Educational Progress (NAEP) in Mathematics. Figure 1 shows that 12 states had over 30 percent of students score at/above Proficient level in 2000, and 28 states improved 4 or more percentage points over the decade.**
- **Even though significant progress has been made, still, in the nation, only a quarter of grade 8 students meet the Proficient math level established for NAEP. We also find that in almost half the states the average student did not perform significantly better in 2000 than in 1990.**

➢ **As you study** Figure 1 and Table 1, consider the following questions about State Trends on NAEP Math Grade 8:

- Nationally, 26 percent of students scored at/above the Proficient level in 2000, an improvement of 11 percentage points from 1990. What is the level of improvement for your state for the decade?
- Eight states improved student performance in the 1990s above the national average (Connecticut, Illinois, Indiana, Maryland, Michigan, Minnesota, North Carolina, Ohio). Do you have information about the programmatic efforts made in these states to improve math education, or to improve public school education as a whole?
- What initiatives or programs in your state would you cite as related to your state's performance on NAEP mathematics assessments? Do the NAEP trends agree with other data within your state (such as trends on state assessment)?
- What is a benchmark or goal for improvement for your state on this indicator? How do you set a benchmark for improvement?

FIGURE 1 **Percent of Grade 8 Students at or above Proficient Mathematics Level, 1990 to 2000 NAEP**



SOURCE: The Nation's Report Card, Mathematics 2000, U.S. Department of Education.
Council of Chief State School Officers, State Education Assessment Center, Washington, D.C., 2001.

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Goal for Improvement

In using statistical indicators, state educators and policymakers typically ask about the performance of students in their state relative to other states, how much improvement has occurred over time, and what the state performance goals should be. Concerning the latter issue, we suggest that educators in a state can plan targets for improvement in scores on NAEP as they would scores on their state assessment. Student improvement in mathematics should be reflected in NAEP scores as well as on the tests mandated by the state. Thus, one approach to setting a benchmark for your state on NAEP would be to set a similar level of gain as expected on the state assessment in math.

States should set a goal for improvement on NAEP since it is a standard, reliable measure across states. There are significant differences between most state assessments in math and the NAEP assessment. A comparative analysis of the NAEP Mathematics Framework should be completed so that leaders have a basis for confidence in their target benchmark for improvement during the four-year NAEP assessment intervals, i.e., level of improvement from 2000 to 2004.

How do NAEP scores vary within state vs. between states?

In Table 1, the far right column displays the NAEP scores by the state average on the NAEP scale. The scale ranges from 0 to 500 and includes grades 4, 8, and 12. The state averages are divided into deciles in the NAEP Report Card (http://nces.ed.gov/nationsreportcard). Examining the distribution of grade 8 NAEP 2000 scores by state, the data show that variation in math proficiency is much greater within each state than are the differences between the states. For example, if we consider the distribution of student scores in Minnesota, the difference in scores between students at the 10th percentile and students at the 90th percentile is 84 points (243 vs. 327). The difference between the average proficiency of Minnesota students and the average proficiency of Mississippi students is 34 points (288 vs. 254). Students in the highest scoring state are performing in mathematics approximately three grades higher than students in the lowest state (based on grade 8 average score at 274 vs. grade 4 average at 226, or a difference of about 12 scale points per grade).

TABLE 1 Mathematics Proficiency of Grade 8 Students, 2000 NAEP; Improvement 1990 to 2000

STATE	PROFICIENT %, 2000	PROFICIENT Change 1990 to '00	% at Advanced Level, 2000	Average Proficiency, 2000
Minnesota #	40	+17 &&	7	288
Montana #	37	+10 &&	6	287
Connecticut	34	+12 &&	6	282
Kansas #	34	–	4	284
Maine #	32	–	6	284
Massachusetts	32	–	6	283
Oregon #	32	+11 &&	6	281
Vermont #	32	–	6	283
Indiana #	31	+14 &&	5	283
Nebraska	31	+7 &&	5	281
North Dakota	31	+4	4	283
Ohio	31	+16 &&	5	283
North Carolina	30	+21 &&	6	280
Maryland	29	+12 &&	6	276
Michigan #	28	+12 &&	5	278
DDESS	27	–	6	277
DoDDS	27	–	4	278
Idaho #	27	+9 &&	3	278
Illinois #	27	+12 &&	4	277
NATION	**26**	**+11 &**	**5**	**274**
New York #	26	+11 &&	4	276
Utah	26	–	3	275
Virginia	26	+9 &&	5	277
Wyoming	25	+6 &&	4	277
Rhode Island	24	+9 &&	4	273
Texas	24	+11 &&	3	275
Missouri	22	–	2	274
Arizona #	21	+8 &&	3	271
Kentucky	21	+11 &&	3	272
Nevada	20	–	2	268
Georgia	19	+5 &&	3	266
Oklahoma	19	+6 &&	2	272
California #	18	+6 &&	3	262
South Carolina	18	–	2	266
West Virginia	18	+9 &&	2	271
Tennessee	17	–	2	263
Alabama	16	+7 &&	2	262
Hawaii	16	+4 &&	2	263
Arkansas	14	+5 &&	1	261
New Mexico	13	+3 &&	1	260
Louisiana	12	+7 &&	1	259
Mississippi	8	–	1	254
District of Columbia	6	+3 &&	1	234
Guam	4	0	1	233
American Samoa	1	–	*	195

NOTES: # Indicates jurisdiction did not meet one or more of the guidelines for school participation.
* Percentage is between 0.0 and 0.5.
& Significantly different from 2000 if only one jurisdiction or the nation is being examined.
&& Significantly different from 2000 when examining only one jurisdiction and when using a multiple comparison procedure based on all jurisdictions that participated both years.
– Indicates jurisdiction did not participate.

SOURCE: The Nation's Report Card, Mathematics 2000 (see for standard errors of estimates).
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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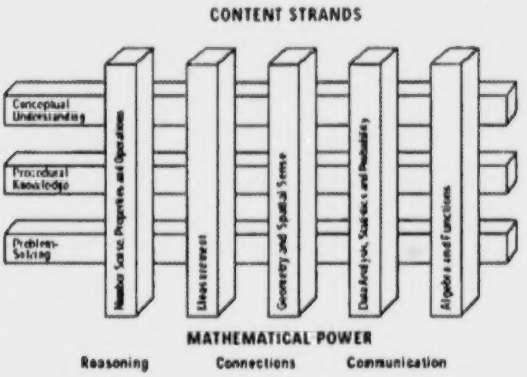
Mathematics Framework for the 1996 Assessment



Source: NAEP 1996 Mathematics Report Card for the Nation and the States, U.S. Department of Education.

The definition of the "Proficient" level is established by the National Assessment Governing Board (NAGB, 1996/2000):

> *Eighth grade students performing at the Proficient level should apply mathematical concepts and procedures consistently to complex problems in the five NAEP content strands--Number Sense, Properties, and Operations; Measurement; Geometry and Spatial Sense; Data Analysis, Statistics and Probability; and Algebra and Functions.*
> [Note: The Mathematics Framework for 2000 was the same as the 1996 Framework.]

NAEP Assessments and Levels

NAEP results began to be reported using three achievement levels--Basic, Proficient, Advanced--in 1993 (Mullis, et al.). Prior to that point, only the NAEP scale was reported. CCSSO also chose to report the NAEP levels in reporting state mathematics and science indicators (Blank and Gruebel, 1993). NAEP scores are more understandable and interpretable by the public and by educators when reported against standards for the expected knowledge and skills in a subject, e.g., mathematics, rather than being reported in relation to the performance of other students as is done in norm-referenced testing and reporting. In the 1990s, states have moved toward use of achievement or proficiency levels for reporting student achievement results in state assessment programs, partly due to requirements for Title I programs under the Improving America's Schools Act of 1994 (*State Education Indicators with a Focus on Title I;* Manise et al., 2001; see http://publications.ccsso.org/).

The NAEP assessments in mathematics and science are based on rigorous, challenging academic standards. They include multiple types of tasks—multiple-choice items, short open-ended questions, and extended or "constructed response" tasks in mathematics and "hands-on," laboratory tasks in science. The Proficient level on NAEP mathematics could be viewed as a more challenging standard than "proficient" as defined with many state assessments, when state assessment results are compared to NAEP scores. A recent report from CCSSO provides both sets of data (Manise, et al., 2001).

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Improvement in Mathematics Proficiency of Grade 4 Students

- **From 1992 to 2000, 25 states made significant improvement in the percentage of grade 4 students reaching the Proficient level on the NAEP mathematics assessment. Figure 2 and Table 2 show that 16 states had at least 25 percent of students score at/above the Proficient level in 2000.**
- **Nationally, 25 percent of grade 4 students scored at/above the Proficient level, or a gain of eight points from 1992 to 2000.**

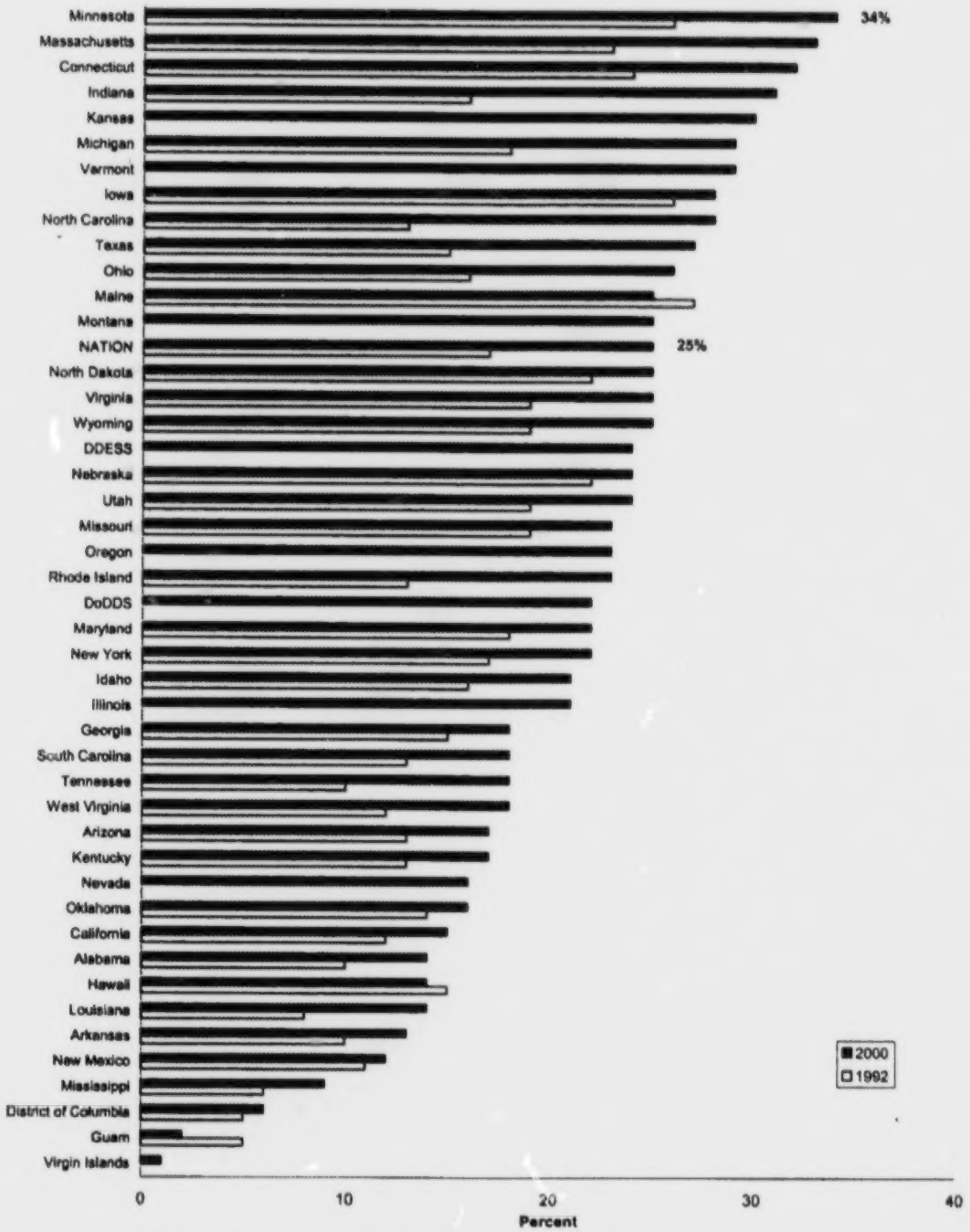
➢ **As you study** Grade 4 Math Trends in Figure 2 and Table 2, consider:

- What is your state's level of progress since 1992? How does your state's progress compare with grade 4 trends for other states in your region?
- How do your state's trends on NAEP since 1992 compare to trends on your state assessment for grade 4?
- How does your state's progress on NAEP for grade 4 compare to trends on grade 8 NAEP?
- If you examine your NAEP state report online (http://nces.ed.gov/nationsreportcard/mathematics/), what is the extent of variation in grade 4 trends since 1992 for students in urban vs. suburban, vs. rural schools?
- What is a benchmark or goal for improvement on grade 4 NAEP mathematics?

Our analysis has emphasized the Proficient level on NAEP. But a state may decide that the Basic level on NAEP is an important, relevant target following a detailed review of the NAEP definition of Basic. With two-thirds of all students currently at or above the Basic NAEP level, a state might decide to set the goal of 100 percent of its students to be at/above the Basic level. Then, benchmarks for gauging progress could be based on some portion of the difference between current performance and 100 percent.

The NAEP scores for Mathematics can be disaggregated by content strands in the mathematics assessment framework. The averages by content areas—numbers/operations, measurement, statistics/probability, algebra/functions, data/statistics, and geometry—are available from the NAEP report card. The NAEP results in these tables and graphs show a statistical distribution of where states are in relation to other states and the nation, but it is difficult to get an idea of what mathematics students at a given level can actually do. To see a glimpse of the mathematics content and skills of students represented by the NAEP scores and levels, you can go to the NAEP report card on the web to view sample tasks from 2000 and obtain the percentage of students scoring well on the problem and the percentage for students at or above the Proficient level (http://nces.ed.gov/nationsreportcard/mathematics/).

FIGURE 2 **Percentage of Students in Grade 4 at or above Proficient Mathematics Level, 1992 to 2000 NAEP**



SOURCE: The Nation's Report Card, Mathematics 2000, U.S. Department of Education.
Council of Chief State School Officers, State Education Assessment Center, Washington, D.C., 2001.

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TABLE 2 Mathematics Proficiency of Grade 4 Students, 2000 NAEP; Improvement 1992 to 2000

STATE	PROFICIENT %, 2000	Change 1992 to '00	% at or Above Basic Level, 2000	% at Advanced Level, 2000	Average Proficiency, 2000
Minnesota #	34	+8 &&	78	3	235
Massachusetts	33	+10 &&	79	3	235
Connecticut	32	+8 &&	77	3	234
Indiana #	31	+15 &&	78	3	234
Kansas #	30	--	75	3	232
Michigan #	29	+11 &&	72	3	231
Vermont #	29	--	73	4	232
Iowa #	28	+2	78	2	233
North Carolina	28	+15 &&	76	3	232
Texas	27	+12 &&	77	2	233
Ohio #	26	+10 &&	73	2	231
Maine #	25	-2	74	2	231
Montana #	25	--	73	2	230
NATION	25	+8 &	67	2	226
North Dakota	25	+3	75	2	231
Virginia	25	+6 &&	73	2	230
Wyoming	25	+6 &&	73	2	229
DDESS	24	--	70	3	228
Nebraska	24	+2	67	2	226
Utah	24	+5 &&	70	2	227
Missouri	23	+4 &&	72	2	229
Oregon #	23	--	67	3	227
Rhode Island	23	+10 &&	67	2	225
DoDDS	22	--	70	2	228
Maryland	22	+4 &	61	2	222
New York #	22	+5 &&	67	2	227
Idaho #	21	+5 &&	71	1	227
Illinois #	21	--	66	2	225
Georgia	18	+3	58	1	220
South Carolina	18	+5 &&	60	2	220
Tennessee	18	+8 &&	60	1	220
West Virginia	18	+6 &&	68	1	225
Arizona	17	+4 &	58	2	219
Kentucky	17	+4 &&	60	1	221
Nevada	16	--	61	1	220
Oklahoma	16	+2	69	1	225
California #	15	+3	52	1	214
Alabama	14	+4 &&	57	1	218
Hawaii	14	-1	55	1	216
Louisiana	14	+6 &&	57	1	218
Arkansas	13	+3 &&	56	1	217
New Mexico	12	+1	51	1	214
Mississippi	9	+3 &&	45	*	211
District of Columbia	6	+1	24	1	193
Guam	2	-3 &&	21	*	184
Virgin Islands	1	--	15	*	183
American Samoa	*	--	5	0	157

NOTES: # Indicates jurisdiction did not meet one or more of the guidelines for school participation.
* Percentage is between 0.0 and 0.5.
& Significantly different from 2000 if only one jurisdiction or the nation is being examined.
&& Significantly different from 2000 when examining only one jurisdiction and when using a multiple comparison procedure based on all jurisdictions that participated both years.
-- Indicates jurisdiction did not participate.

SOURCE: The Nation's Report Card, Mathematics 2000 (see for standard errors of estimates).
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Improvement in Science Proficiency of Grade 8 Students

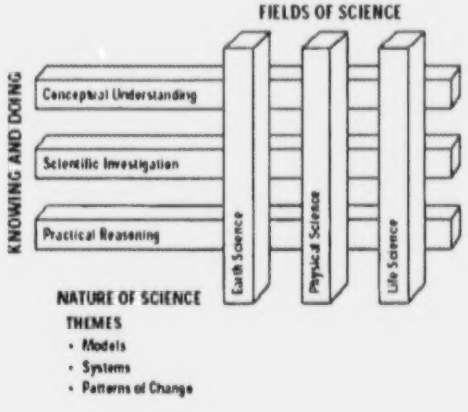
- **From 1996 to 2000, only nine states made significant improvement in the percentage of grade 8 students reaching the Proficient level on the NAEP science assessment. Table 3 shows that 13 states had more than 35 percent of students score at/above the Proficient level in 2000.**
- **Nationally, 30 percent of grade 8 students scored at/above the Proficient level, or a gain of three points.**

➢ **As you study** Grade 8 Science Trends in Table 3, consider:

- What is your state's level of progress since 1996? How does your state progress compare with NAEP science trends for other states in your region?
- How do your state's trends on NAEP since 1996 compare to trends on your state assessment for science at grade 8?
- If you examine your NAEP state report online (http://nces.ed.gov/nationsreportcard/science/), what is the extent of variation in grade 8 trends since 1996 for students in urban vs. suburban, vs. rural schools?
- What is a benchmark or goal for improvement on grade 8 NAEP science?

In 1996 and 2000, the NAEP science assessment was based on a new assessment framework. Half of the assessment time for the grade 8 science NAEP involved hands-on or constructed response exercises. This is a major change from earlier NAEP science exams prior to 1990, as reported in the national long-term NAEP trends. The NAEP science assessment framework, shown graphically below, included six content strands.

Science Framework for the 1996 Assessment



Source: Adapted from the National Assessment Governing Board's Science Framework for the 1996 National Assessment of Educational Progress.

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TABLE 3 Science Proficiency of Grade 8 Students, 2000 NAEP; Change 1996 to 2000

STATE	PROFICIENT %, 2000	Change 1996 to '00	% at or Above Basic Level, 2000	% at Advanced Level, 2000	Average Proficiency, 2000
Montana #	46	+5	80	5	165
Massachusetts	42	+5 ▲	74	5	161
Minnesota #	42	+5	73	5	160
Ohio	41	--	73	6	161
North Dakota	40	-1	74	4	161
Vermont #	40	+6 ▲▲	74	4	161
Idaho #	38	--	73	4	159
DoDDS	37	+6 ▲▲	72	4	159
Maine #	37	-4	75	3	160
Michigan #	37	+5	69	4	156
Missouri	36	+8 ▲▲	68	4	156
Nebraska	36	+1	70	4	157
Wyoming	36	+2	71	3	158
Connecticut	35	-1	65	4	154
DDESS	35	+8 ▲▲	70	4	159
Indiana #	35	+5	68	3	156
Utah	34	+2	68	3	155
Oregon #	33	+1	67	3	154
Virginia	31	+4	63	3	152
Illinois #	30	--	62	3	150
NATION	**30**	**+3**	**59**	**4**	**149**
New York #	30	+3	61	2	149
Kentucky	29	+6 ▲▲	62	3	152
Rhode Island	29	+3	61	3	150
Maryland	28	+3	59	3	149
North Carolina	27	+3	58	3	147
Oklahoma	26	--	62	2	149
West Virginia	26	+5 ▲▲	61	2	150
Tennessee	25	+3	57	2	146
Arizona #	24	+1	57	2	146
Arkansas	23	+1	54	2	143
Georgia	23	+2	52	2	144
Nevada	23	--	54	2	143
Texas	23	0	53	2	144
Alabama	22	+4 ▲	51	2	141
New Mexico	20	+1	48	1	140
South Carolina	20	+3	50	2	142
Louisiana	18	+5 ▲	45	2	136
California #	15	-5	40	1	132
Hawaii	15	0	40	1	132
Mississippi	15	+3	42	1	134
Guam	6	-1	22	*	114
American Samoa	2	--	5	0	72

NOTES: # Indicates jurisdiction did not meet one or more of the guidelines for school participation.

* Percentage is between 0.0 and 0.5.

▲ Significantly different from 2000 if only one jurisdiction or the nation is being examined.

▲▲ Significantly different from 2000 when examining only one jurisdiction and when using a multiple comparison procedure based on all jurisdictions that participated both years.

SOURCE: The Nation's Report Card: Science 2000.

Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Proficient: Students performing at the Proficient level in science demonstrate much of the knowledge and many of the reasoning abilities essential for understanding of the earth, physical, and life sciences at a level appropriate to grade 8. For example, students can interpret graphic information, design simple investigations, and explain such scientific concepts as energy transfer. Students at this level also show an awareness of environmental issues, especially those addressing energy and pollution.
[Note: The 2000 NAEP science assessment framework is the same as the 1996 framework.]

To give readers a better picture of what grade 8 students who score well on NAEP know and can do in science, public release tasks from the NAEP assessment are available on the web (http://nces.ed.gov/nationsreportcard). Also available on the web is a graphic listing of the types of items students got correct at different points on the NAEP scale.

Examine TIMSS Results for Further Information

The Third International Mathematics and Science Study (TIMSS) was conducted in 1994–1995 in 41 countries around the world. The achievement results were reported by country for grades 4, 8, and 12 over a three-year period (NCES 1996, 97, 98; Beaton et al., 1996, 1997, 1998). The TIMSS data provide not only additional measures of the performance of our students against an international framework but detailed data on curriculum content, teaching practices, and school conditions that are extremely important for explaining differences in student performance (http://nces.ed.gov/timss/).

In 1999, a number of states and districts in the U.S. voluntarily participated in the TIMSS-R, which was conducted four years after the 1995 study. The 1999 study provided all of the kinds of achievement results and supporting data analyses that were collected and reported in the original study plus an assessment of the change/improvement in math and science education since the 1995 TIMSS results. The 1999 benchmarking reports show the participating states and districts their scores and data on grade 4 and grade 8 math and science within an international context (Mullis, et al., 2001; Martin, et al., 2001).

Mathematics and Science Proficiency by Student Race/Ethnicity

A high priority for the Council's science and mathematics indicators is reporting on trends in equity in educational opportunity, conditions, and outcomes. One approach to indicators of equity in math and science education is disaggregating state averages according to differences in students' race/ethnicity and gender. For example, in 2000, 77 percent of white students scored at/above Basic as compared to 32 percent of African American students.

- **The NAEP results in Figure 3 indicate that only eight states made a reduction in disparity in mathematics achievement of two or more percentage points from 1992 to 2000 (often called "closing the achievement gap").**
- **For the nation, the difference between white and Hispanic students scoring at/above the Basic level was reduced by 11 percentage points over the eight-year period, and the white–African American disparity was reduced by two points.**

Figure 3 illustrates the disparity between the percent of white students at/above the Basic level on NAEP mathematics at grade 8 and the percent for the largest minority group in each state. For example, the disparity in 2000 for Oklahoma is 13 percentage points—the difference between 71 percent of white students at or above the Basic level and 58 percent of American Indian students. (See Table 4 for data on minority performance for five groups in each state.)

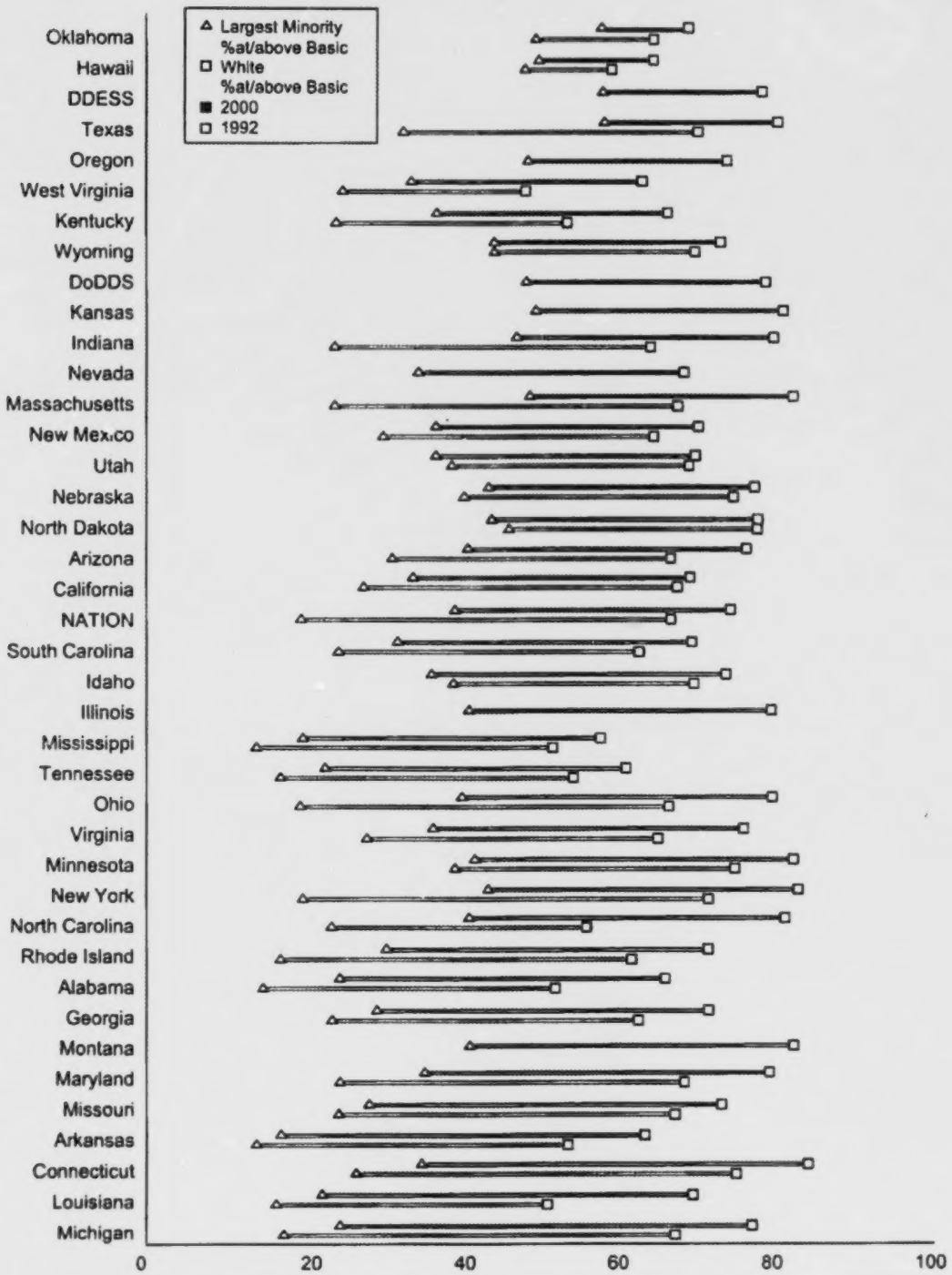
The minority–white disparity measure for analyzing race/ethnic differences in student achievement is based on the percent of students at or above the Basic level on NAEP because the state percentages for each race/ethnic group are often too small for useful comparisons. Student performance at Basic level does **not** mean students are meeting a minimum level of expectations for the subject (as in the "minimum competency" tests used by states in the 1970s). The definition of "Basic" set by the Governing Board is:

> *Eighth-grade students performing at the Basic level should exhibit evidence of conceptual and procedural understanding in the five NAEP content strands. This level of performance signifies an understanding of arithmetic operations, including estimation, on whole numbers, decimals, fractions, and percents.*

➢ **As you study** Figure 3 and Table 4, consider the following:

- What is the achievement gap for your state at the NAEP Basic level?
- Does this difference agree with other data from your state? If not, why would the NAEP results show a different result for groups in your state?
- What do you know about any of the states that have reduced the disparity in scores? What accounts for change? Are there policy, curriculum, or instructional changes that can be highlighted?
- Do you have evidence of progress in closing the gap within your state through educational change in specific districts or schools? Have the lessons from these changes been documented and disseminated for others?

FIGURE 3 Disparity in Basic Mathematics Level Between Largest Minority Group and White Students, Grade 8, 1992 to 2000 NAEP



SOURCE: The Nation's Report Card, Mathematics 2000 (see for standard errors of estimates).
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

TABLE 4 Race/Ethnic Differences in Basic Mathematics Level for Grade 8 Students, 2000 NAEP

	White	African American	Hispanic	Asian/ Pacific Islander	American Indian	Disparity White-Minority 2000	Change in Disparity 1992 to '00
NATION	77	32	40[&]	75	50	37	-11
STATE							
Alabama	67	24[&]	29	•	•	43	+5
American Samoa	•	•	1	9[&]	•	–	–
Arizona #	78	39	41[&]	71	•	37	+1
Arkansas	65	18[&]	25	•	•	47	+6
California #	71	25	34[&]	72	•	37	-4
Connecticut	86	31	37[&]	76	•	49	-1
District of Columbia	•	20[&]	23	•	•	–	–
DDESS	79	54	59[&]	•	•	20	–
DoDDS	81	49[&]	62	77	•	32	--
Georgia	73	30[&]	34	•	•	43	+4
Guam	•	•	14	25[&]	•	–	–
Hawaii	66	41	37	52[&]	•	14	+5
Idaho #	76	•	37[&]	•	•	39	+8
Illinois #	81	42[&]	51	•	•	39	–
Indiana #	81	48[&]	57	•	•	33	-5
Kansas #	83	42	51[&]	•	•	32	–
Kentucky	67	38[&]	•	•	•	29	-1
Louisiana	71	22[&]	26	•	•	49	+14
Maine #	77	•	•[&]	•	•	–	–
Maryland	81	36[&]	57	90	•	45	0
Massachusetts	83	43	49[&]	80	•	34	-10
Michigan #	79	25[&]	51	•	•	54	+3
Minnesota #	84	•	43[&]	•	•	41	+4
Mississippi	59	20[&]	15	•	•	39	0
Missouri	75	29[&]	41	•	•	46	+2
Montana #	84	•	68	•	41[&]	43	–
Nebraska	79	31	44[&]	•	•	35	0
Nevada	70	35	37[&]	71	56	33	--
New Mexico	72	•	38[&]	•	30	34	+1
New York #	85	44[&]	47	77	•	41	-12
North Carolina	83	42[&]	57	•	•	41	+8
North Dakota	80	•	•	55	•	45[&]	35	+3
Ohio	81	41[&]	58	•	•	40	-7
Oklahoma	71	33	45	•	58[&]	13	-3
Oregon #	75	51	50[&]	71	•	25	–
Rhode Island	73	32	31[&]	62	•	42	-3
South Carolina	71	33[&]	34	•	•	38	-1
Tennessee	62	23[&]	38	•	•	39	0
Texas	83	40	59[&]	83	•	24	-14
Utah	72	•	38[&]	66	•	34	+4
Vermont #	76	•	•[&]	•	•	–	–
Virginia	78	38[&]	56	89	•	40	+3
West Virginia	64	37[&]	46	•	•	27	+4
Wyoming	74	•	45[&]	•	42	29	+3

NOTES: # Indicates jurisdiction did not meet one or more of the guidelines for school participation.
& Race/ethnic minority group with largest enrollment.
• Sample size insufficient to permit reliable estimate.
For change in disparity: "-" means *decline* in disparity; "+" means *increase* in disparity.
– Data not available.

SOURCE: The Nation's Report Card, Mathematics 2000 (see for standard errors of estimates).
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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National Trends on NAEP by Race/Ethnicity and Gender

NCES reports and analyzes two national trends for NAEP mathematics and science scores due to the change in the NAEP assessment frameworks and change in the methods of assessment starting in 1990.

(A) *Long-Term NAEP Trends on Mathematics and Science*. The original NAEP trend analysis, going back to its inception in 1969, is based on a core set of multiple-choice test items and the initial assessment framework that tracks the degree of change in students' mathematics and science knowledge over almost 30 years. CCSSO has chosen to analyze NAEP trends from 1982 to present to track change in student performance following the education reforms and policy initiatives developed at state and national levels in response to *A Nation at Risk*, the highly influential report of the National Commission on Excellence in Education (1983).

(B) *Main NAEP Assessment in Mathematics*. In 1990, a new NAEP mathematics framework was applied in developing the assessment, and open-ended questions were introduced to the assessment. In 1992, extended constructed-response questions were added to the math assessment. NCES and NAGB established a new trend line in 1990 for mathematics. In the 1996 NAEP Report Card for Mathematics trends are analyzed for the new main NAEP over the six-year period.

To examine NAEP math and science trends by student race/ethnicity and by gender for both national trends, go to the NAEP Report Card (http://nces.ed.gov/nationsreportcard/) and the NAEP trends report (http://nces.ed.gov/nationsreportcard/about/trend.asp).

Students Taking Advanced Placement Examinations

- **The data reported in Table 5 show that nationally 6 percent of grade 12 students took AP mathematics examinations in 2000, and 7 percent took science examinations. This compares to 4 percent in mathematics in 1992 and 5 percent in science in 1994.**
- **The results also show that ten states increased participation in AP math exams by 4 percentage points or more from 1992 to 2000. In science, nine states increased the percentage of students taking AP science (Biology, Chemistry or Physics) exams by 4 or more percentage points from 1994 to 2000.***[2]

Each year the College Board offers Advanced Placement (AP) examinations in a range of academic subjects for public and private school students in each state. If students receive a composite score of 3, 4, or 5, they can receive a college credit for the subject. Many high school students enroll in courses that follow the AP curriculum. The number of high school students in a state taking AP examinations and the proportion who receive a qualifying (passing) score provide an indicator of high-level student achievement. Caution should be used in interpreting this indicator since AP exams represent a voluntary group of students, and states and districts may differ significantly in how students are enrolled in AP courses and apply to take the exams.

➢ **As you study** Table 5 and Table 6:

- What percentage of grade 12 students took AP exams in math and science in 2000 in your state, and what is the amount of change since 1992?
- What factors account for the change in your state?
- How does the rate of change since 1992 in your state compare to the other states in your region (e.g., AP exams appear more prevalent in middle Atlantic states: Maryland, New Jersey, New York, DC)?
- What is a benchmark or goal for your state on this indicator?
- How much improvement in AP participation has been made among female and minority students in your state?

Nationally, 6 percent of grade 12 students were taking AP Calculus in 2000, which represents a total of 123,000 students, and 7 percent took an AP exam in science in 2000, which represents a total of 137,000 (figures based on state enrollment data).

Scores of 3 or higher on AP exams qualified students for college credit, sixty-six percent were awarded credit nationally in AP Calculus and sixty-two percent in science (Biology, Chemistry, or Physics).

[2] These totals include both public and private schools. Nationally, 80 percent of AP exams in all subjects are taken by public school students. Please note that the percentage of grade 12 students is used for statistical comparison across states—AP exams are not limited to grade 12 students.

TABLE 5 Students Taking Advanced Placement Examinations in Mathematics and Science, 2000; Trends 1992 to 2000

STATE	AP CALCULUS			AP SCIENCE*		
	% of Grade 12 Students Taking Exam, 2000	% Receiving Qualified Score	Change 1992 to '00 % of Grade 12	% of Grade 12 Students Taking Exam, 2000	% Receiving Qualified Score	Change 1994 to '00 % of Grade 12
Dist. of Columbia	17	69	+9	25	78	+12
New York	11	66	+3	15	68	+5
New Jersey	10	70	+4	13	69	+4
Virginia	10	62	+4	9	60	+3
Delaware	10	68	+4	10	70	+2
Maryland	10	72	+4	10	66	+3
Massachusetts	10	76	+4	12	70	+5
Connecticut	9	75	+4	13	73	+6
Utah	8	78	+2	8	68	-1
North Carolina	8	61	+4	10	53	+4
Hawaii	8	72	+2	12	66	+5
New Hampshire	8	70	+3	7	66	+3
California	8	66	+3	10	61	+4
South Carolina	7	61	+1	6	59	0
Florida	7	66	+2	9	52	+3
Illinois	6	74	+1	7	73	+1
Colorado	6	69	+2	6	66	+2
Georgia	6	59	+3	7	57	+1
NATION	**6**	**66**	**+2**	**7**	**62**	**+2**
Indiana	6	48	+2	6	42	0
Minnesota	6	64	+4	4	58	+3
Maine	6	63	+3	6	60	+3
Michigan	6	68	+3	7	65	+3
Vermont	6	75	+2	7	71	+2
Pennsylvania	6	69	+3	6	61	+2
Wisconsin	5	74	+3	5	65	+3
Rhode Island	5	65	+1	6	63	+2
Texas	5	59	+3	6	49	+4
Alaska	5	62	+2	5	54	+2
Ohio	5	68	+2	5	68	+2
Washington	5	68	+3	4	71	+2
Tennessee	4	67	+1	5	64	+2
New Mexico	4	53	+1	4	48	+1
Kentucky	4	60	+2	5	45	+2
South Dakota	4	63	+4	4	52	+3
Arizona	4	62	+1	4	55	0
Nevada	4	71	+2	5	61	+2
Oklahoma	3	61	+1	4	53	+2
Oregon	3	77	+1	3	69	+1
Idaho	3	66	+1	3	68	+1
Missouri	3	72	+2	3	68	+1
West Virginia	2	59	0	2	52	0
Wyoming	2	68	0	2	59	+1
Alabama	2	61	0	3	61	0
Arkansas	2	54	+1	3	48	+2
Iowa	2	75	+1	2	70	+1
Montana	2	59	+1	2	64	+1
Mississippi	2	40	+1	2	43	+1
North Dakota	2	79	+1	2	74	+1
Kansas	2	74	+1	2	72	+1
Louisiana	2	60	+1	1	67	0
Nebraska	2	69	+1	2	60	+1

EXAMPLE: 10% of grade 12 students in New Jersey took the AP Calculus exam in 2000, 70% of those students received 3, 4, or 5 score; in 1992, 6% of grade 12 students took the exam.

NOTES: State totals include public and private schools. * AP Science = students taking AP Biology, Chemistry, or Physics.

SOURCE: The College Board (2000). Advanced Placement Program, National and 50 States Summary Reports.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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AP Exams by Race/Ethnicity and Gender

An important feature of this indicator is measuring progress in minority and female participation in AP exams, as shown in Table 6.

- **Nationally, 26 percent of students taking AP Calculus exams were minority students, and 28 percent taking AP science exams were minority students.**
- **In 2000, 45 percent of students taking AP Calculus exams were female, and 46 percent taking science exams were female.**

We do not find change in the national average for minority students taking AP calculus exams since 1992, but nine states show increased rates of 3 points or more.

In science, minority rates increased 2 points nationally since 1994, but 13 states raised their minorities' participation rate by 3 points or more, led by Texas with a 19-point increase.

Female participation in AP Calculus has not increased as a national percentage from 1994 to 2000 (still 45 percent). Participation in science AP exams increased from 44 percent to 46 percent over six years.

(For detailed state-level data on participation of each minority group in AP exams for each subject, please go to the CCSSO 2001 report on our website: http://www.ccsso.org/SciMathIndicators01.html.)

TABLE 6 Minority and Female Students Taking Advanced Placement Examinations in Mathematics and Science, 2000; Change 1992 to 2000 in Minority Participation

	AP CALCULUS			AP SCIENCE		
STATE	% Minority of Students Taking AP Calculus, '00	Change 1992 to '00 % Minority	% Female of Students Taking Exam, '00	% Minority of Students Taking AP Science, '00	Change 1994 to '00 % Minority	% Female of Students Taking Exam, '00
Hawaii	78	+2	52	78	+1	48
California	54	+1	47	51	+2	46
Texas	38	+7	46	39	+19	47
New Mexico	34	+9	45	33	+3	42
Dist. of Columbia	31	+2	45	25	-10	42
Florida	31	+2	46	30	+2	47
New Jersey	31	+4	43	30	+1	46
New York	28	+1	48	27	-6	49
Georgia	27	+7	48	29	+3	49
NATION	**26**	**0**	**45**	**28**	**+2**	**46**
Maryland	25	0	46	30	-1	45
Nevada	25	+1	37	25	+4	39
Virginia	24	+4	47	26	+2	49
Oklahoma	24	+6	45	25	+3	44
Illinois	24	-3	45	29	0	44
Washington	23	+3	45	22	+4	46
Louisiana	21	-3	45	23	0	45
Mississippi	20	+7	51	24	+6	53
Alabama	19	0	46	18	-7	47
Arizona	19	-3	45	22	0	46
Delaware	19	+1	46	21	+2	47
South Carolina	19	0	49	18	+2	53
Massachusetts	18	0	44	18	+2	45
Connecticut	17	+1	45	17	-2	46
Alaska	16	0	42	17	+9	45
Tennessee	15	-3	47	18	-2	49
North Carolina	15	+1	49	17	-2	51
Michigan	15	-1	44	18	-2	46
Colorado	15	-7	42	17	+1	45
Kansas	15	0	42	17	-8	42
Oregon	14	+1	39	17	+1	42
New Hampshire	14	0	38	16	+3	40
Pennsylvania	13	-2	44	14	0	45
Missouri	12	-4	43	14	+1	41
Ohio	11	-4	44	15	-2	46
Rhode Island	11	-7	43	10	-1	45
Arkansas	10	-5	47	11	-2	46
Minnesota	10	+1	44	11	0	46
Iowa	9	+2	38	9	-1	41
Indiana	9	-2	44	11	-1	48
Wyoming	9	+5	39	7	+4	44
West Virginia	8	-3	39	12	+3	41
Nebraska	8	+1	42	9	+1	41
Kentucky	7	+1	47	7	+1	50
Wisconsin	6	-1	43	7	-3	47
Utah	6	0	40	8	+3	39
Idaho	5	0	38	6	0	37
South Dakota	5	+2	43	5	-2	49
North Dakota	4	-5	48	8	+1	39
Maine	3	-2	43	5	+3	49
Vermont	3	-4	42	4	-5	55
Montana	2	-5	45	3	0	47

NOTES: State totals include public and private schools. Minority students = sum of African American, Hispanic, Asian/Pacific Islander, American Indian, etc.
% AP Science = Students taking AP Biology, Chemistry, or Physics.

SOURCE: The College Board (2000). Advanced Placement Program, National and 50 States Summary Reports.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Chapter Two

Indicators of Mathematics and Science Curriculum

Course Enrollments in High School and Middle Grades Math and Science
State Policies and Course Enrollment Trends
Instructional Practices in Mathematics and Science
Class Time on Mathematics and Science

State policymakers and science and math educators have expressed strong interest in having indicators of curriculum content and instructional practices in schools. A system of education indicators typically focuses first on student achievement as the primary measure of the outcome of schooling. Then, educators, policymakers, and the public would like to be able to understand differences in student achievement in terms of how and what students are taught. These kinds of indicators help to inform efforts to develop teachers' knowledge and skills, and to improve the design and delivery of mathematics and science curriculum.

Secondary-student course enrollments in mathematics and science.

CCSSO has reported indicators of student course-taking in science and math by state since 1990. There are four main reasons for focusing on these indicators:

- Research on patterns of student achievement in math and science has consistently shown that the amount of time in instruction and the number and level of secondary courses students take are strongly related to achievement.[3]
- States have an interest in determining the proportion of students that progress through the secondary science and mathematics curricula to higher course levels—for example, Algebra 2, Trigonometry, and Pre-calculus in math, and Chemistry, Physics, and Advanced Biology or Physical Science courses—because they indicate the proportion of students being offered more challenging content, which usually aligns with state content standards for science and math.[4]
- Course-taking patterns can be analyzed by state policies on high school graduation requirements, which have shown significant increases since the mid-1980s.

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[3] Many studies show the relationship between course-taking and achievement (Husen, 1967; Jones, L.R., Mullis, Raizen, Weiss, & Weston, 1992; Jones, L.V., Davenport, Bryson, Bekhuis, & Zwick, 1986; Rock, Braun, & Rosenbaum, 1985; Sebring, 1987; Walberg, 1984). Analyses of recent NAEP results show that high mathematics proficiency has a high correlation with level of mathematics courses students have completed (Mullis et al., 1993; Shaughnessy, et al., 1998; Wilson & Blank, 1999). We also know that instructional time and course-taking in math and science vary widely across U.S. schools, and that they are correlated with the socioeconomic status of students in our schools (Goodlad, 1984; Horn & Hafner, 1992; McKnight et al., 1987; Oakes, 1990; Lee, Bryk, & Smith, 1993; Weiss, 1994).

[4] Two years of high school mathematics has been shown to be an important door to success in college, particularly for minority students. Analysis of college attendance and completion rates shows that taking two years of high school mathematics is a strong predictor of whether minority students complete a college degree (Pelavin & Kane, 1990).

- The course enrollments by state also are useful for tracking how states and schools are progressing in offering opportunities for science and math to students from all race/ethnic groups and for female and male students.

Instructional Practices in Mathematics and Science Classrooms.

States have found the data from NAEP teacher and student questionnaires that accompany the mathematics and science assessments to be very useful in providing state-by-state information on instructional practices in their states (e.g., Reese, et al., 1997; Shaughnessy, et al., 1998; O'Sullivan, et al., 1997). For example, NAEP survey data are available on classroom use of math manipulatives and calculators as well as on different instructional strategies, e.g., student work in small groups and average time homework is assigned. These variables and data can be analyzed by characteristics of schools and teachers. For many state users, NAEP achievement results become most valuable when analyzed with information on instruction, resources, and teachers. Aggregate statistics on practices at the state level can be useful in tracking a specific practice that has strong policy interest, such as use of calculators. Secondly, instructional practices can be analyzed along with other variables, such as measures of curriculum, teacher preparation, or school characteristics in a multivariate research model to explain differences in achievement. Individual response items about practice are typically combined to form a scale to measure a key concept, such as "active learning in mathematics" or in science.

In prior reports in this series, CCSSO reported on specific instructional practices in math and science that appear to indicate the kinds of teaching recommended in state and national content standards (Blank & Langesen, 1997, 1999). The selected practices in math and science are continued in this volume. Additional measures of instruction at grades 4 and 8 are available from the NAEP database (http://www.nces.gov/NAEP/search.asp).

Elementary Class Time Spent on Mathematics and Science.

A basic indicator of curriculum and instruction is the amount of time that teachers spend teaching a subject. At the elementary level, there is wide variation by school, district, and state on how time is used in teaching various subjects. Sample surveys with teachers, such as the Schools and Staffing Survey conducted by NCES, can provide basic data on differences in time devoted to mathematics and science and to other subjects.

Subject Content Taught in Classrooms.

Reliable, comparable data on content of instruction in specific science and math courses or grades are not available across states. Several states and districts have participated in efforts to study subject content through large data collection projects, and others may be interested in developing these indicators within their own state.

International studies have provided comparative data on the "implemented curriculum" that students actually receive in classrooms, and these data have been effectively related to student achievement. The Third International Mathematics and Science Study (TIMSS) measured student achievement in 41 countries based on mathematics and science assessment frameworks developed by consensus of the participating countries (NCES, 1996, 1997, 1998; Beaton, et al., 1996). The study included surveys with teachers and students that had a goal of collecting reliable, comparable data on the "implemented curriculum" in math and science classrooms

across the participating countries. For example, the TIMSS results include analysis of the percentage of class time grade 8 mathematics teachers report they spent teaching 30 different topics such as fractions, decimals, equations, area, two-dimensional figures, etc.

Another method of measuring and analyzing subject content taught in mathematics and science—called the "Survey of Enacted Curriculum (SEC)"—has been developed and tested by CCSSO in a collaborative project with 11 states and the Wisconsin Center for Education Research, and through grant support from NSF. Two reports are available that demonstrate how the surveys are implemented and how the data are useful to states, local districts, and schools for a variety of purposes (see http://www.ccsso.org/projects/sec.html; CCSSO, 2000; Blank, Porter, & Smithson, 2001). The SEC data assist educators in conducting reliable comparisons of data on instructional practices, subject content (by topics and by expectations for students), teacher preparation, professional development, and classroom resources. The data can also be used to analyze the relationship of instruction to assessment, to study the alignment of standards and instruction, and to conduct needs assessment or program evaluation.

Course Enrollments in High School Mathematics and Science

Students Taking Higher-Level Mathematics Courses by Graduation

- **The trends data for 2000 shown in Figure 4 indicate that nine states had over three-fourths of high school students take Algebra 2 or Integrated Math 3 by graduation. A total of 14 states increased math enrollments more than 15 percentage points during the ten-year period, 1990 to 2000.**
- **Nationally, 62 percent of students took Algebra 2 or Integrated Math 3 in 2000, as compared to 49 percent in 1990. We are using this course level as an indicator of students taking three years of high school math by graduation.**
- **Data in Table 7 show that the share of high school graduates that took *four years* of high school mathematics increased from 29 percent in 1992 to 37 percent of graduates in 2000.**

Policy Issues:

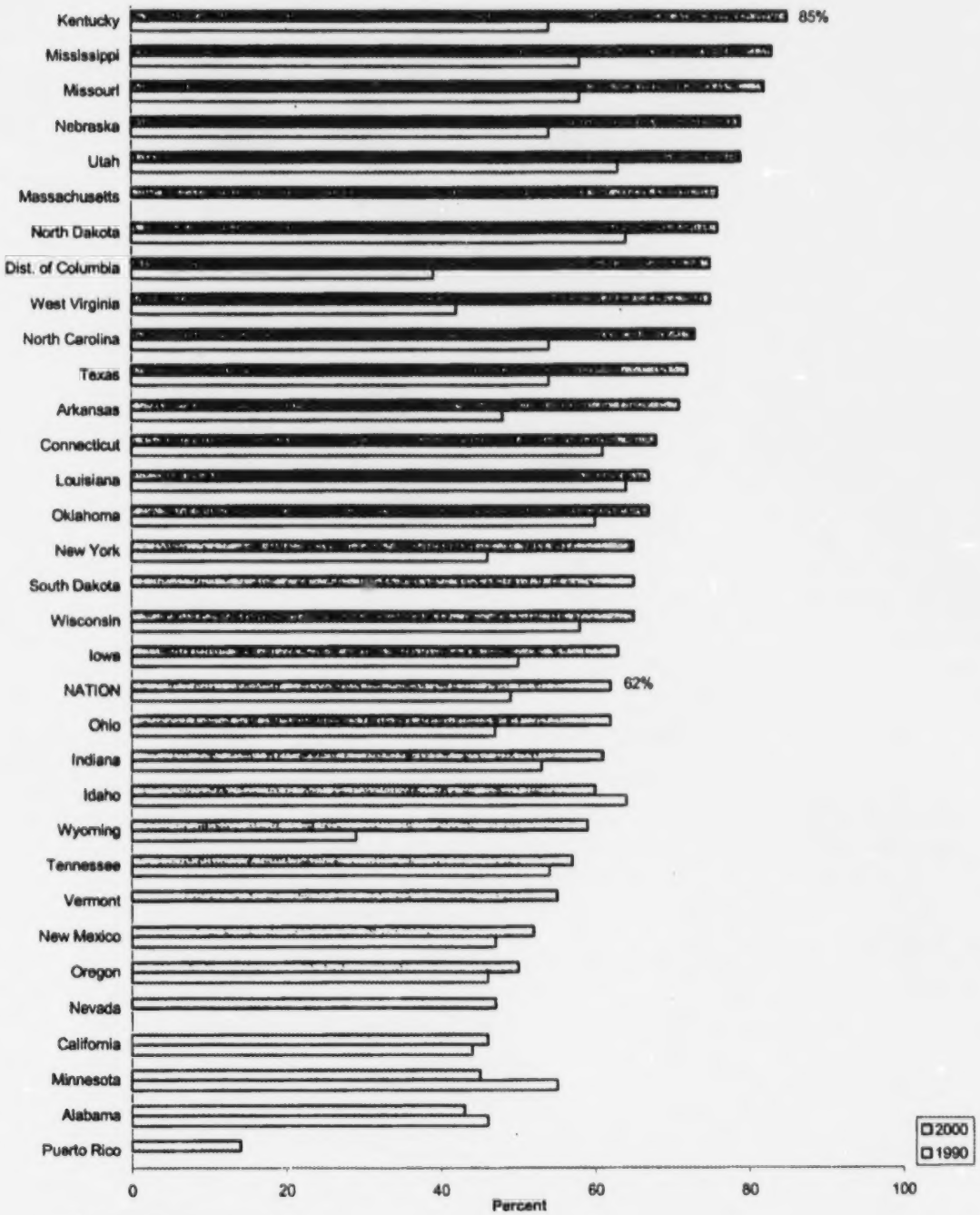
*** What proportion of students take challenging subject content in mathematics and science, indicated by course enrollments in high school curricula?**

*** What are trends in mathematics and science course-taking for students, reported by gender and race/ethnicity?**

*** Are schools improving the performance of all students?**

Many states have set three years of high school mathematics as a requirement for graduation, following the recommendations from *A Nation at Risk* (National Commission on Excellence in Education, 1983). Figure 4 reports the percentage of high school students in each state that take three high school mathematics courses by graduation, as of the 1999-00 school year, and the change in enrollments from 1990 to 2000. The states are ordered by the percentage of students taking Algebra 2 or Integrated Math 3 by graduation (generally, the third year of mathematics in the high school curriculum). The percentage of students reaching three years of high school mathematics varies from over 80 percent (Kentucky, Mississippi, Missouri) to less than 50 percent (five states). Trends are shown for those states with consistent data reported over the period.

FIGURE 4 Percent of High School Students Taking Algebra 2/Math Level 3 by Graduation, 1990 to 2000



(1) see note on percent computation.

SOURCE: State Departments of Education, Data on Public Schools, 1999–00.
Council of Chief State School Officers. State Education Assessment Center. Washington. D.C.. 2001.

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Table 7 reports the percentage of high school students taking each of five levels of mathematics (Algebra 1 through Calculus) by their graduation, and we report the percentage change in students taking these courses since 1990. The states are ranked by the percentage taking Algebra 2 or Integrated Math 3 (level 3). The state percentages for Algebra 1/Integrated Mathematics 1 include enrollments during high school, as well as in grade 8.

- **As you study** Figure 4 and Table 7, consider the following questions about enrollments in math courses:

- What percentage of students in your state take Algebra 1 or Integrated Mathematics 1 by the time they graduate, according to the data from states? How does your state compare to the national average for Algebra 1/Integrated Math 1 enrollments (i.e., 95 percent-plus of those students that graduate)[5]?
- How does your state percentage of students taking Algebra 2 and Geometry by graduation compare with national statistics (62 percent and 74 percent)? What are reasons for the rate of higher-level math enrollments in your state?
- Do you have a reason to question the accuracy or completeness of these data? What would make your state's math course data non-comparable to the data for other states in your region?

[5] A group of states, including Georgia, Louisiana, Mississippi, North Carolina, and Texas require that students pass algebra 1 in order to graduate. (See CCSSO, *Key State Education Policies for K-12 Education, 2000*, for graduation requirements by subject in each state: http://publications.ccsso.org).

TABLE 7 Students Taking Higher-Level Mathematics Courses by Graduation, 2000; Change 1990 to 2000

STATE	Algebra 2/ Integrated Math 3 (Level 3)		Algebra 1/ Integrated Math 1 (Level 1)		Geometry/ Integrated Math 2 (Level 2)		Trigonometry/ Precalculus (Level 4)		Calculus/AP Calculus, AP Statistics (Level 5)	
	% 2000	Change 1990 to '00	% 2000	Change 1990 to '00	% 2000	Change 1990 to '00	% 2000	Change 1990 to '00	% 2000	Change 1990 to '00
Kentucky	85	+31	95+	+14	80	+13*	45	+15*	11	+5
Mississippi	83	+25	95+	+10	93	+29*	47	+18*	7	+4
Missouri	82	+24	95+	0	74	+10*	38	+22*	16	+8
Nebraska	79	+25	95+	+20	90	+23*	59	+37*	18	+12
Utah	79	+16	95+	+13	90	+19*	44	+10*	16	+3
North Dakota	76	+12	95+	0	84	+3*	45	-4*	7	+4
Massachusetts	76	--	95+	--	81	--*	52	--*	22	--
Dist. of Columbia	75	+36	95+	+30	87	+21*	18	+1*	9	+6
West Virginia	75	+33	93	+20	78	+23*	62	+35*	12	+10
North Carolina	73	+22	95+	+26	95+	+28*	74	+34*	12	+4
Texas	72	+18	95+	+13	95+	+30*	32	+6*	40	+35
Arkansas	71	+23	87	-1	88	+28*	39	+12*	8	+3
Connecticut	68	+7	95+	+21	80	+17*	49	+11*	26	+12
Oklahoma	67	+7	95+	0	68	+15*	28	+5*	12	+4
Louisiana	67	+3	95+	0	79	--*	41	--*	7	+3
Wisconsin	65	+29	95+	+16	92	+11*	47	+13*	23	+14
South Dakota	65	--	85	--	54	--*	50	--*	21	--
New York	65	+19	95+	+26	81	+25*	41	+13*	18	+6
Iowa	63	+13	94	+2	66	-10*	44	+12*	9	0
Ohio	62	+15	95+	+15	74	+12*	46	+11*	9	+1
NATION	**62**	**+13**	**95+**	**+14**	**74**	**+13***	**37**	**+8***	**17**	**+8**
Indiana	61	+16	94	+34	70	+12*	37	+7*	14	+6
Idaho	60	-4	95+	0	62	-1*	27	+3*	16	+10
Wyoming	59	+30	80	+7	57	-6*	32	+4*	12	+4
Tennessee	57	+3	75	-4	55	-3*	31	+2*	2	-2
Vermont	55	+2*	89	+19*	63	+6*	39	+9*	14	+3*
New Mexico	52	+5	92	-3	48	-8*	22	-1*	6	-2
Oregon	50	+4*	86	+6*	61	+10*	26	+3*	11	+1*
Nevada	47	+15	88	-2	64	+13*	18	-1*	8	+3
California	46	+2	95+	+3	56	+9*	24	+3*	12	+3
Minnesota	45	-10	65	-25	49	-22*	38	+4*	15	+3
Alabama	43	-3	66	-4	62	+6*	24	+5*	11	+5
Puerto Rico	14	--	86	--	58	-7*	7	-2*	--	--

EXAMPLE: 79% of Utah students took Algebra 2 or Integrated Math 3 (3rd year of high school math) prior to graduation, based on data from 1999-00 school year. This represents an increase of 16 percentage points since the 1989-90 school year.

NOTES: -- Data not available. Ohio: 97-98 data; Vermont: data includes imputation.
(1) Each state percent is a statistical estimate of course taking of public high school students by the time they graduate based on the total course enrollment in grades 9-12 in fall 1998 divided by the estimated number of students in a grade cohort during four years of high school. The statistical estimating method is imprecise above 95%. Nation = Percent of all public high school students estimated to take each course, including imputation for nonreporting states (see Appendix A). Algebra 1 percentages include grade 8 Algebra 1, except Iowa and Texas.
* Change 1992 to 2000.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Integrated Math

Table 8 highlights the proportion of students taking Integrated Math 1, which is often taken in place of first-year algebra, in the 16 states that collected detailed data on this course. *Integrated courses* help teachers organize curriculum and instructional strategies that bring together key concepts often taught in separate high school courses, such as algebra, geometry, and functions.

TABLE 8 **Integrated Mathematics Course Enrollments as a Percentage of Grade 9 Students, 2000**

STATE	Integrated Math 1 % of grade 9
California	17
Connecticut	13
Dist. of Columbia	4
Idaho	3
Indiana	6
Kentucky	6
Massachusetts	11
Nevada	3
New Mexico	1
New York	87
Oregon	25
South Dakota	2
Utah	0.4
Vermont	13
Wisconsin	2
Wyoming	5

NOTES: --Data not available. Vermont: data includes imputation.
New York students enrolled in grades 9, 10, or 11.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00;
NCES, CCD Fall Membership 1998.

Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

Enrollments by Grade

Many educators and policymakers are interested in tracking *the specific grade* at which high school students take certain math and science courses. Table 9 reports enrollments in two levels of high school math courses by grade. The data show different patterns in enrollments in Algebra 1/Integrated Math 1 across the states. For example, Indiana, North Dakota, South Dakota, Texas, and Wisconsin enroll over 60 percent of students in this course level in ninth grade. Other states have a distribution of students across grades 9, 10, and 11.

In a majority of states, grade 11 has the largest enrollments in Algebra 2/Integrated Math 3—from 25 percent to 39 percent of students in grade 11. From 10 percent to 40 percent of students take Algebra 2 in grade 10, and states have from 5 percent to 15 percent taking the course in grade 12.

TABLE 9 Students Taking Algebra 1/Integrated Math 1 and Algebra 2/ Integrated Math 3 as a Percent of Students in Each High School Grade, 2000

	ALGEBRA 1 OR INTEGRATED MATH 1				ALGEBRA 2 OR INTEGRATED MATH 3			
STATE	**% Grade 9**	**% Grade 10**	**% Grade 11**	**% Grade 12**	**% Grade 9**	**% Grade 10**	**% Grade 11**	**% Grade 12**
Alabama	28	17	6	2	3	9	26	6
Arkansas	55	7	0.2	0.003	11	42	13	0.5
California	56	27	5	1	2	11	28	5
Connecticut	46	19	9	3	3	18	35	14
DoDEA	42	25	16	8	1	17	23	10
Idaho	55	21	3	2	4	16	37	3
Indiana	64	15	2	0.3	2	22	35	2
Missouri	51	14	12	12	11	23	30	16
New Mexico	38	22	12	5	2	14	25	11
North Carolina	75	39	15	5	2	25	31	16
North Dakota	63	16	4	6	1	23	39	12
Puerto Rico	7	74	3	3	0	6	6	1
South Dakota	61	11	3	1	1	21	38	5
Texas	69	22	6	2	2	21	36	12
Utah	45	23	8	3	7	32	28	11
Vermont	41	19	6	2	3	17	25	9
West Virginia	44	16	6	3	4	28	30	13
Wisconsin	72	23	8	3	3	20	32	10
Wyoming	36	19	7	2	4	19	26	10

NOTE: Vermont: data includes imputation.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00; NCES, CCD Fall Membership 1998.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Students Taking Higher-Level Science Courses by Graduation

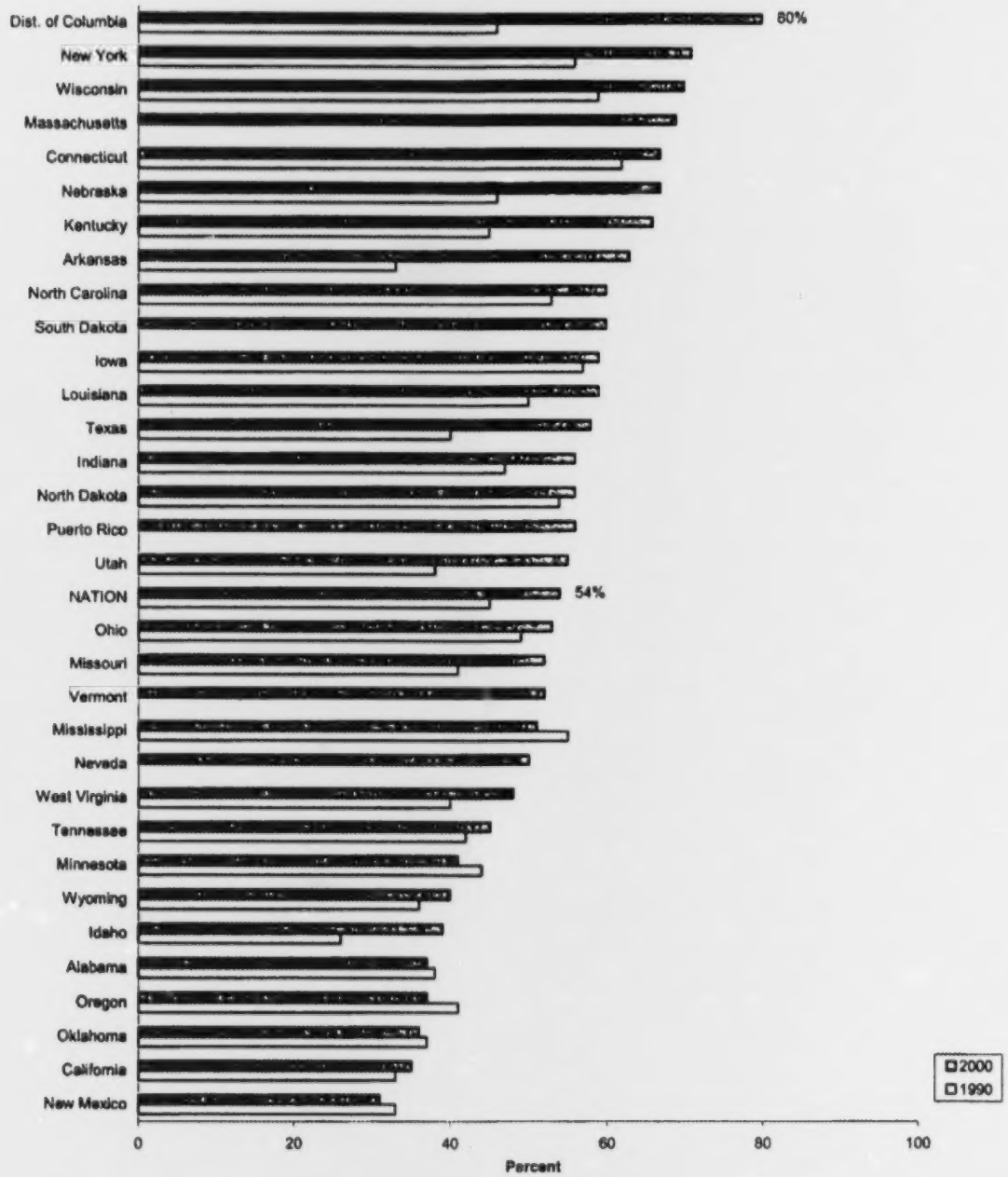
- **The trends data in Figure 5 show that ten states had 60 percent or more of their students taking Chemistry by graduation as of 2000. A total of eight states raised enrollments in Chemistry by more than 15 percentage points from 1990 to 2000**
- **Nationally, 54 percent of students took Chemistry by graduation in 2000, as compared to 45 percent in 1990, an increase of 9 percentage points in ten years.[6]**

In Figure 5, states are ordered by the percentage of students taking Chemistry by graduation. The graphs allow each state to see its progress in enrollments since 1990. Table 10 shows the percentage of high school students in each state that took courses in Chemistry, Physics, and Biology by graduation. The table also shows the percentage change for each state from 1989–1990 to 1999–2000. The states are ordered by the percentage of students that took Chemistry by graduation. The trends for Physics enrollments show increased enrollment by over 10 percentage points in five states. In eight states, more than 30 percent of students took Physics by graduation, with the national average for Physics enrollment at 23 percent, an increase of 3 points over the decade. Nationally, over 95 percent of students complete a first-year course in Biology, and this course level is attained in most states.

[6] National trends on course-taking based on states data can be compared with results from national sample surveys of high school transcripts, from studies conducted by NCES since 1982.

- In 1982, 33 percent of high school graduates took Algebra 2, and results for 1998 graduates show the rate increased to 58 percent of graduates.
- In 1982, 31 percent of graduates took Chemistry, and by 1998, the national sample data show 61 percent of graduates took Chemistry. (NCES, *The 1998 High School Transcript Study Tabulations, 2001).*

FIGURE 5 **Percent of High School Students Taking Chemistry by Graduation, 1990 to 2000**



(1) see note on percent computation.

SOURCE: State Departments of Education, Data on Public Schools, 1999–00.
Council of Chief State School Officers. State Education Assessment Center. Washington. D.C.. 2001.

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TABLE 10 Students Taking Higher-Level Science Courses by Graduation, 2000; Change 1990 to 2000

STATE	CHEMISTRY % 2000	CHEMISTRY Change 1990 to '00	PHYSICS % 2000	PHYSICS Change 1990 to '00	BIOLOGY % 2000	BIOLOGY Change 1990 to '00
Dist. of Columbia	80	+34	5	-8	77	+2
New York	71	+15	33	+5	95+	0
Wisconsin	70	+19	34	+9	95+	0
Massachusetts	69	--	44	--	90	--
Nebraska	67	+21	34	+13	95+	0
Connecticut	67	+5	38	+2	95+	0
Kentucky	66	+21	19	+5	92	-3
Arkansas	63	+30	33	+20	95+	0
North Carolina	60	+13	18	+3	95+	0
South Dakota	60	--	23	--	78	--
Louisiana	59	+9	23	+2	95+	+5
Iowa	59	+2	27	0	95+	0
Texas	58	+18	23	+11	95+	0
Indiana	56	+14	23	+4	95+	0
North Dakota	56	+2	25	+1	95+	0
Puerto Rico	56	--	26	--	81	--
Utah	55	+18	39	+19	95+	+15
NATION	**54**	**+9**	**23**	**+3**	**95+**	**0**
Ohio	53	+4	23	+3	95+	0
Missouri	52	+11	19	+3	95+	+9
Vermont	52	0*	32	+1*	80	-2*
Mississippi	51	-4	15	-2	95+	0
Nevada	50	+17	22	+9	93	+28
West Virginia	48	+8	25	+14	95+	0
Tennessee	45	+3	9	-2	80	-8
Minnesota	41	-3	19	-4	77	-18
Wyoming	40	+4	21	+5	79	-7
Idaho	39	+13	15	0	95+	+15
Oregon	37	-4*	20	-1*	73	-11*
Alabama	37	-1	12	-9	64	-31
Oklahoma	36	-1	10	0	90	-3
California	35	+2	16	0	67	-24
New Mexico	31	-2	11	-4	76	-19

EXAMPLE: 66% of Kentucky students took Chemistry (i.e., three years of high school science) prior to graduation, based on data from 1999-00 school year. This represents an increase of 21 percentage points since the 1989-90 school year.

NOTES: -- Data not available. Vermont: data includes imputation. West Virginia: Coordinated science includes biology, chemistry, and physics; 48% = 3 years coordinated science.
(1) see note on percent computation.
* = Change 1992 to 2000.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Table 11 shows enrollments of high school courses in Earth Science, Physical Science, General Science, and Integrated or Coordinated Science in 1999–00 as well as the change in enrollments for these initial high school science courses, since 1996. Not all students take these courses in grade 9, but this is a common pattern, and using grade 9 enrollment as the denominator improves state comparisons. These data are useful to educators interested in tracking the patterns in science course-taking across states, and we see marked differences in course enrollments by state.

➢ **As you study** Figure 5 and Tables 10 and 11, consider the following questions about enrollments in science courses:

- Does the trend in first-year chemistry enrollments provide a useful benchmark of progress of students in the high school science curriculum for your state?
- Do you prefer, instead, to analyze AP or other advanced science course trends (available by state in our on-line Appendix: http://www.ccsso.org/SciMathIndicators01.html)?
- How do the science enrollments in different course levels for your state compare with those states in your region? How do you account for changes and trends?
- What are the trends in first-year high school courses, e.g., Earth Science, Physical Science, and General Science?
- What are the trends for integrated or coordinated science in your state?[7] What accounts for different trends in your region?

[7] Several states now have a substantial percentage of students taking an integrated or coordinated science curriculum, often starting in grade 7 and continuing through grade 9 or 10. A *coordinated* science curriculum treats the disciplines of biology, chemistry, physics, and earth/space science individually and equitably and focuses on an overarching idea in the sciences that can be explained in terms of all four disciplines. An *integrated* science curriculum intentionally blurs the traditional disciplinary lines and treats science as a whole, under the assumption that the disciplines should not be separated in the secondary curriculum (California Scope, Sequence & Coordination Project, 1995).

TABLE 11 Students Taking Earth Science, Physical Science, General Science, and Integrated Science as a Percent of Grade 9 Students, 1996 to 2000

PERCENT OF GRADE 9 STUDENTS

	Earth Science		Physical Science		General Science		Integrated or Coordinated Science	
STATE	% 2000	Change 1996 to '00	% 2000	Change 1996 to '00	% 2000	Change 1996 to '00	% 2000	Change 1996 to '00
Alabama	9	+7	48	-19	--	--	--	--
Arkansas	10	-73	92	+12	7	+7	--	--
California	8	-1	23	-8	7	-3	37	+19
Connecticut	39	-1	21	-4	27	+3	12	+8
Dist. of Columbia	12	-10	0.02	--	2	0	--	--
DoDEA	11	+9	10	+3	--	--	20	-64
Idaho	57	-6	39	+3	3	-2	--	--
Indiana	35	+7	15	-7	3	-7	3	0
Iowa	37	+11	62	+17	--	--	15	--
Kentucky	10	+7	29	-16	--	--	35	0
Louisiana	11	-1	79	+13	6	-10	0.4	--
Massachusetts	27	-1	31	0	10	-2	34	+27
Minnesota	10	0	45	+5	--	--	4	+1
Mississippi	5	+3	43	+9	--	--	--	--
Missouri	17	+2	60	-4	12	-3	--	--
Nebraska	32	-11	54	+2	27	+4	--	--
Nevada	44	--	7	--	16	--	3	--
New Mexico	11	+4	41	0	11	-9	5	--
New York	75	+8	1	-7	3	-6	3	-2
North Carolina	44	+5	68	-9	--	--	--	--
North Dakota	4	+1	108	+2	1	--	--	--
Ohio	17	-4	23	-3	1	-40	51	--
Oklahoma	7	+3	69	0	3	-3	--	--
Oregon	13	0	37	+2	11	+2	21	0
Puerto Rico	27	+1	0.5	0	72	+1	--	--
South Dakota	11	-7	69	+8	6	+3	--	--
Tennessee	7	0	62	-15	--	--	--	--
Texas	8	0	--	--	--	--	61	+59
Utah	38	+4	13	-7	--	--	53	+20
Vermont	37	--	20	--	4	--	15	--
West Virginia	1	--	--	--	--	--	99	+18
Wisconsin	26	0	47	-11	14	-7	6	--
Wyoming	37	--	22	--	11	--	4	--

NOTES: -- Data not available. Vermont: data includes imputation. Some students take these courses beyond grade 9; West Virginia students take Integrated Science in grade 9, 10, or 11.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00; NCES, CCD Fall Membership 1998.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Additional Data by Course on the Web

On the CCSSO website we provide additional tables with more detailed data on science and mathematics course enrollments by state, including enrollments in "general" versus "applied" Biology, Chemistry, and Physics; data on review and informal high school mathematics courses and computer science courses; and enrollments by state in advanced/second-year courses and Advanced Placement (AP) courses. See Appendix B for a complete list of the course categories collected by state.

Science Enrollments by Grade

As with selected mathematics courses, CCSSO aggregated data from states on science course enrollments by specific grade at which high school students take a course. Enrollments in first-year Biology are reported by grade in Table 12. Twenty states were able to report their enrollment data by the grade at which students took the course in 1999–00. The data show divergent patterns in *first-year Biology* course-taking patterns. For example, Indiana enrolls two-thirds of students in Biology in grade 9, and Texas, Arkansas, and Wisconsin have about one-third of students taking Biology in grade 9. DoDEA, Idaho, North Dakota, South Dakota, and Wisconsin have most students taking Biology in grade 10, while Missouri schools enroll many students in Biology across all four grades.

TABLE 12 **Students Taking First-Year Biology as a Percent of Students in Each High School Grade, 2000**

	BIOLOGY, 1ST YEAR			
STATE	**% Grade 9**	**% Grade 10**	**% Grade 11**	**% Grade 12**
Alabama	23	34	4	2
Arkansas	29	77	0.4	0.1
California	15	45	5	2
Connecticut	19	70	9	7
DoDEA	20	70	12	3
Idaho	6	81	15	6
Indiana	64	24	3	1
Missouri	28	38	13	12
New Mexico	17	46	9	3
North Carolina	20	67	8	2
North Dakota	3	87	9	8
Ohio	25	49	17	12
Puerto Rico	0	71	9	2
South Dakota	5	68	4	2
Texas	45	41	7	2
Utah	45	69	18	10
Vermont	14	58	7	2
West Virginia	0.1	0.1	0.3	0.3
Wisconsin	29	66	8	3
Wyoming	8	60	8	3

NOTE: Vermont: data includes imputation.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00; NCES, CCD Fall Membership 1998.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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State Policies and Course Enrollment Trends

Policy Issues:

*** Have enrollments in higher-level courses increased since many states raised graduation requirements?**

*** Do states with policies setting higher course requirements for graduation have higher rates of course-taking in science and mathematics?**

Current efforts toward science and math reform are aimed at high standards for the content of what students know and can do. Even though content and performance standards are currently the favored approach to education reform, it is still important to monitor and report on the effects of major policy initiatives, such as raising course requirements, because such initiatives continue to be used widely as a strategy for encouraging higher-level content for more students.

In the 1980s, over 40 states raised the number of credits in science and mathematics required for graduation (Blank & Espenshade, 1988; Blank & Dalkilic, 1992). In the 1990s states continued to increase requirements in science and math for graduation. As of 2000:

- **22 states require 2.5 to three credits of mathematics and four require four credits;**
- **16 states require 2.5 to three credits of science and four require four credits;**
- **18 states require two mathematics credits, and 21 states require two science credits** (see CCSSO, Key State Policies, 2000a; http://www.ccsso.org/pdfs/KeyState2000.pdf).

As of 2000, 42 states require at least two years of math and science, while in 1980, only nine states had this requirement. In 1992, only 13 states required 2.5 or more credits of math and only six states required 2.5 or more credits in science, compared to 26 and 20 states in 2000.

Higher science and math course enrollments have increased significantly in the same period of increasing course credit requirements. We have found that the states with the highest requirements have had slightly higher overall course enrollments in science and mathematics. However, because rates have gone up in almost all states, it is hard to determine specific effects of different policies on course-taking. Porter's recent study of effects of state requirements at the local level did show that students were taking more mathematics and science courses in high school, and key courses such as Algebra, Biology, and Chemistry did not have their curriculum content reduced as a result (Porter, et al., 1994).

Mathematics Trends by State Policies

- **Twenty-three of 33 states reporting on trends since 1990 in Table 13 show an increase of 5 or more percentage points in the proportion of high school students taking higher level mathematics.**
- **Nationally, 46 percent of high school students took higher-level math courses in 2000, an increase of 12 points from 1990; and 88 percent of high school students took a math course during the 1999–2000 school year.**

CCSSO can now track the amount of change in course enrollments in relation to an individual state's requirements. Table 13 shows change from 1990 to 2000 in the percentage of public high school students in the state, during one school year, that are taking higher-level mathematics, i.e.,

Geometry (level 2) through Calculus (level 5). The states are grouped according to the requirements for graduation as of 2000. In the third column of Table 13, we show the proportion of students in each state taking mathematics at any level in 2000. The national total of 88 percent is an increase of five points from 83 percent in 1990.

Science Trends by State Policies

- **Twenty-four of 33 states reporting on trend data on course enrollments since 1990 (Table 14) show an increase of 3 percentage points or more in the proportion of high school students taking higher-level science courses, and ten states increased enrollments by 10 points or more.**
- **Nationally, 28 percent of high school students took higher-level science courses in 2000, an increase from 21 percent in 1990. A total of 80 percent of high school students were taking a science course during the 1999–00 school year.**

Table 14 shows change from 1990 to 2000 in the percentage of high school students taking higher-level science (i.e., Chemistry, Physics, or advanced/second-year courses). This display allows a state to examine its trends and to determine the possible relationship to requirements for graduation.

In the third column of Table 14, we show the proportion of students in each state taking science at any level in 2000. The national total of 80 percent of high school students represents an increase of 7 percentage points since 1990.

- **As you study** Tables 13 and 14, consider the following questions about trends by state policies:

- What are likely reasons behind the pattern of change in higher-level math and science enrollments for your state?
- Are there factors other than graduation requirements that are related to your state's rate since 1990? What is the role of state content standards?

TABLE 13 Change in Higher-Level Mathematics Enrollments by State Graduation Requirements, 1990 to 2000

PERCENT OF GRADES 9-12 STUDENTS

STATE (By Requirements)	% Students Taking Math at Level 2, 3, 4, or 5		% Students Taking Math (any course)
	2000	Change 1990 to 2000	2000
2.5 to 4 Credits (as of 2000)			
Alabama	34	+6	63
Arkansas	51	+20	75
Connecticut	53	+15	99
Dist. of Columbia	46	+16	99
DoDEA	47	+7	99
Idaho	41	+3	74
Indiana	44	+11	82
Kentucky	53	+18	97
Louisiana	46	+3	90
Mississippi	55	+17	99
Nevada	34	+8	85
New Mexico	31	+1	75
North Carolina	61	+24	99
North Dakota	53	+9	92
Puerto Rico	20	+1	84
Tennessee	35	+7	73
Texas	56	+21	86
Vermont	41	+4	80
West Virginia	56	+26	99
Wyoming	40	+15	70
2 Credits (as of 2000)			
California	34	+5	69
Missouri	51	+15	75
New York	48	+14	93
Ohio	47	+11	90
Oklahoma	43	+9	78
Oregon	37	+5	72
South Dakota	47	--	74
Utah	57	--	97
Wisconsin	56	+9	89
1 Credit or Local Board Policies			
Iowa	45	+2	92
Massachusetts	56	--	93
Minnesota	36	-5	58
Nebraska	60	+24	99
NATION	**46**	**+12**	**88***

EXAMPLE: 53% of Connecticut's 9-12 students took higher level math courses in 2000, while in 1990 only 38% took these courses.

NOTES: Math Level 2-5 = Geometry, Algebra 2, Trigonometry, Pre-Calculus, or Calculus.
*% Students Taking Math (any course) does not include imputation for Review Math, Levels 3 and 4.
DoDEA, Oregon, Puerto Rico, Vermont, Wisconsin: change from 1992 to 2000.
-- Data not available. Minnesota: standards-based reform; Ohio: Informal Math and Formal Math=97-98 data; Vermont: data includes imputation.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00; NCES, CCD Fall Membership 1998.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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TABLE 14 Change in Higher-Level Science Enrollments by State Graduation Requirements, 1990 to 2000

PERCENT OF GRADES 9-12 STUDENTS

STATE (By Requirements)	% Students Taking Chemistry, Physics, or Advanced Science 2000	% Students Taking Chemistry, Physics, or Advanced Science Change 1990 to 2000	% Students Taking Science (any course) 2000
2.5 to 4 Credits (as of 2000)			
Alabama	23	+5	60
Arkansas	29	+18	95
Dist. of Columbia	26	+10	76
DoDEA	38	+17	92
Idaho	17	0	72
Indiana	30	+6	72
Kentucky	29	+6	85
Louisiana	23	+5	94
North Carolina	30	+14	97
North Dakota	34	+9	89
Tennessee	19	+3	65
Vermont	27	+1	78
West Virginia	39	+18	99
Wyoming	21	+3	68
2 Credits (as of 2000)			
California	18	+3	61
Connecticut	35	+5	93
Mississippi	42	+7	88
Missouri	31	+4	90
Nevada	25	+11	77
New Mexico	19	+5	61
New York	34	+10	99
Oklahoma	24	+11	77
Oregon	19	0	70
South Dakota	35	--	77
Texas	24	+7	74
Utah	36	--	99
Wisconsin	37	+7	99
1 Credit or Local Board Policies			
Iowa	35	+12	95
Massachusetts	39	--	99
Minnesota	22	-1	60
Nebraska	34	+18	99
Ohio	20	0	74
Puerto Rico	20	-2	69
NATION	**28**	**+7**	**80**

NOTES: DoDEA, Oregon, Puerto Rico, Vermont, Wisconsin: change from 1992 to 2000.
– Data not available. Minnesota: standards-based reform. Vermont: data includes imputation.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00; NCES, CCD Fall Membership 1998.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Middle Grades Mathematics and Science Course Enrollments

- **In twelve states, over 20 percent of students take Algebra 1 in grade 8; and enrollments in algebra increased by 10 percentage points or more in eight states.**
- **Nationally, 20 percent of grade 8 students took Algebra 1 in 2000, an increase of 9 percentage points since 1990.**

The **mathematics** curriculum for middle school students is highly varied between states and within states. Many states and districts are moving toward a grade 8 curriculum with greater emphasis on algebra. In Table 15, state data show that the share of grade 8 students taking algebra varied from 6 percent in Arkansas, Indiana, Louisiana, and Oklahoma to 53 percent in Utah. Pre-algebra courses were taken by 23 percent of students. The 2000 data show that less than half of grade 8 students were taking "regular math" courses.

The course titles provide only a rough estimation of the content students are receiving. Content analyses show wide variation in the content in courses of "Algebra," "Pre-algebra," and "Regular Grade 8 Math," but these categories do provide useful distinctions in the general level of math content that is taught (McKnight, et al., 1987; Shaughnessy, 1998).

The **science** courses and curriculum taught in grades 7-8 vary widely across the states, as shown in Table 16. Nationally, in 2000, 38 percent of grades 7 and 8 students took a general science course, an increase of 12 percent since 1990. Life Science was the course taken by 18 percent of students, which was a decline of 15 points over the decade. Overall, a small decline was found in grades 7-8 Earth Science, and slight increase in Physical Science. Integrated or Coordinated Science has the highest grade 7-8 enrollment in nine states, and this curriculum was developed during the decade.

One issue raised by recent TIMSS achievement results for the United States and data on the curriculum taught to grade 8 students is the wide variation in science content in the subject areas of earth, life, and physical sciences, all of which were tested in the study. The data in Table 16 show enrollment trends for states that reported course data since 1990. We can observe that many states do not have these data available. The states not reporting have extreme difficulty in tracking the science curriculum taught across the state and comparing enrollment patterns within the state or in comparison to other states.

TABLE 15 Grade 8 Mathematics Course Enrollments, 2000; Change 1990 to 2000

MATHEMATICS GRADE 8: PERCENT ENROLLED

STATE	Algebra Grade 8 % 2000	Algebra Grade 8 Change 1990 to '00	Regular Math % 2000	Accelerated/ Pre-Algebra % 2000
Alabama	13	+6	50	--
Arkansas	23	+20	35	29
California	33	+20	32	24
Connecticut	28	+12	31	31
Dist. of Columbia	14	-15 *	66	--
DoDEA	43	+25 *	13	70
Idaho	20	+8	32	29
Indiana	11	+2 *	69	16
Kentucky	12	+1	62	27
Louisiana	6	+1	19	29
Massachusetts	30	--	44	16
Minnesota	13	+7	41	--
Mississippi	14	+7	45	1
Missouri	22	+12	39	--
Nebraska	18	--	0	0
Nevada	13	+6	57	19
New Mexico	17	+9	40	28
New York	--	--	76	--
North Carolina	25	+7 *	52	19
North Dakota	15	-5 *	54	27
Ohio	22	+13	46	9
Oklahoma	9	+2	43	32
Oregon	23	+7 *	37	24
Puerto Rico	--	--	99	--
South Dakota	9	--	73	2
Tennessee	0	--	77	--
Utah	53	+18 *	4	41
Vermont	21	--	57	13
West Virginia	24	+16	1	73
Wisconsin	18	+6 *	70	--
Wyoming	16	-8 *	38	25
NATION	**20**	**+9**	**47**	**23**

NOTES: -- Data not available. Vermont: data includes imputation.
In several states, e.g., Louisiana, Minnesota, Nebraska, data from self-contained classrooms are not included in the totals.
* = Change 1992 to 2000.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00; NCES, CCD Fall Membership 1998.

Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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TABLE 16 Students Taking General Science, Life Science, Earth Science, Physical Science, and Integrated Science as a Percent of Grades 7-8 Students, 2000; Change 1990 to 2000

PERCENT OF GRADES 7-8 STUDENTS

	General Science		Life Science		Earth Science		Physical Science		Integrated or Coordinated Science
STATE	% 2000	Change 1990 to '00	% 2000	Change 1990 to '00	% 2000	Change 1990 to '00	% 2000	Change 1990 to '00	% 2000
Alabama	--	--	--	--	2	--	1	0	82
Arkansas	27	+11	35	-1	38	+3	1	-1	--
California	58	+11	9	-5	1	-4	8	-1	--
Connecticut	40	+21	21	-13	7	-2	14	-14	14
Dist. of Columbia	9	-76	45	--	--	--	36	--	--
DoDEA	24	--	2	--	1	--	0.05	--	90
Idaho	14	+2	36	-2	15	+5	22	0	--
Indiana	94	--	0.2	--	0.4	--	0.2	--	0.5
Kentucky	--	--	6	-22	6	-18	--	--	86
Louisiana	10	-3	23	0	19	+1	--	--	8
Massachusetts	22	--	16	--	9	--	10	--	36
Minnesota	--	--	34	0	27	+3	12	+5	--
Mississippi	--	--	--	--	--	--	--	--	93
Missouri	42	+9	27	-5	22	-3	5	0	--
Nebraska	20	+10	4	-9	7	0	5	-3	--
Nevada	9	+7	10	-13	14	+7	35	+20	4
New Mexico	5	-43	10	-20	27	+4	16	+5	8
New York	12	-3	24	-17	12	-3	33	+4	8
North Carolina	--	--	0.003	--	0.04	-1	0.4	-0.6	93
North Dakota	--	--	48	-3	50	+1	--	--	--
Ohio	59	+25	5	-2	3	-12	1	-4	12
Oklahoma	6	-23	--	--	14	--	2	-2	66
Oregon	12	--	23	--	20	--	15	--	24
Puerto Rico	96	--	--	--	--	--	2	--	--
South Dakota	61	--	8	--	16	--	2	--	1
Tennessee	90	-4	--	--	--	--	--	--	--
Utah	--	--	6	--	3	--	2	--	87
Vermont	22	--	24	--	7	--	16	--	27
West Virginia	--	--	--	--	--	--	--	--	96
Wisconsin	42	+18	21	-22	16	+2	6	-7	1
Wyoming	25	+9	22	-9	19	+3	15	-3	4
NATION	38	+12	18	-15	11	-4	10	+2	#

NOTES: -- Data not available. Percentages may sum over 100%, indicating students reported for more than one subject.
Vermont: data includes imputation.
#Too few states reporting to impute national percent.
In several states, e.g., Nebraska, data from self-contained classrooms are not included in the totals.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00; NCES, CCD Fall Membership 1998.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Course Enrollments by Race/Ethnicity and Gender

Reforms in science and math education aim to increase opportunities among female and male students, and among minority and white students. States are trying to improve the knowledge and skills of all students in mathematics and science, and to raise student confidence by helping them reach challenging levels of course work. The goal of efforts toward equity is to prepare students for further study or to apply knowledge in careers. Evidence of progress by minority students in math and science courses is important because we know that course achievement is a strong predictor of student learning in mathematics and science.

Policy Issues:

*** Are minority students increasing their participation in higher-level science and mathematics?**

*** Is the gender gap closing in higher-level science and mathematics?**

Higher-Level Mathematics and Science by Race/Ethnicity

- **Fourteen states reported enrollments by student race/ethnic group for 2000. African American and Hispanic enrollments in higher-level math and science courses continued to lag behind enrollments for whites and Asians in all the states.**
- **From 1996 to 2000, only four of nine states with trend data for the decade showed increased enrollments in Chemistry and Algebra 2 for Hispanic or African American students.**

State enrollments by race/ethnicity for two course levels (Chemistry and Algebra 2/Integrated Math 3) are reported in Table 17, and trends since 1996 are reported. CCSSO requested data by race/ethnicity from states for the first time in 1993–94. Now, 14 states have education data systems based on student-level records that allow states to aggregate and report enrollments by race/ethnicity. Massachusetts and Texas show the most consistency for gains in enrollments among Hispanic and African American students.

The state percentages by race/ethnicity for students taking Chemistry and Algebra 2/Integrated Math 3 in 2000 can be compared with the percent of each group in the K-12 enrollment shown at the bottom of the page. Our analysis focuses on the major minority groups in each state.

TABLE 17 Race/Ethnic Differences in Students Taking Chemistry and Algebra 2/Integrated Math 3, 1996 to 2000

PERCENT OF HIGH SCHOOL STUDENTS TAKING CHEMISTRY BY GRADUATION

	All Students	White		African-American		Hispanic		Asian		Am. Indian	
STATE	% 2000	% 2000	Change 1996 to '00	% 2000	Change 1996 to '00	% 2000	Change 1996 to '00	% 2000	Change 1996 to '00	% 2000	Change 1996 to '00
Arkansas	63	68	-3	51	+2	25	-40	79	+14	63	+14
Connecticut	67	78	+8	39	-1	32	0	99	+4	89	-6
Idaho	39	42	-1	22	-19	16	-2	65	+24	10	-11
Massachusetts	69	71	-1	72	+27	48	+11	99	+10	69	+35
Nevada	50	59	--	35	--	25	--	88	--	28	--
New Mexico	31	43	--	27	--	23	--	62	--	26	--
North Carolina	60	70	+2	44	-2	39	-23	99	0	40	-22
Ohio	53	56	-4	37	-9	35	-23	96	-3	53	-5
Puerto Rico	56	--	--	--	--	56	0	--	--	--	--
South Dakota	60	65	--	60	--	24	--	67	--	19	--
Texas	58	70	+5	48	+2	47	+8	93	-6	58	+3
Utah	55	59	+10	28	+19	15	-4	44	-3	37	+13
Vermont	52	52	--	58	--	13	--	52	--	10	--
Wyoming	40	43	--	8	--	18	--	50	--	6	--

NOTE: -- Data not available.

PERCENT OF HIGH SCHOOL STUDENTS TAKING ALGEBRA 2/INTEGRATED MATH 3 BY GRADUATION

	All Students	White		African-American		Hispanic		Asian		Am. Indian	
STATE	% 2000	% 2000	Change 1996 to '00	% 2000	Change 1996 to '00	% 2000	Change 1996 to '00	% 2000	Change 1996 to '00	% 2000	Change 1996 to '00
Arkansas	71	75	+4	57	+1	57	-10	89	+22	89	+39
Connecticut	68	78	+7	45	+8	33	-8	78	-20	68	+3
Idaho	60	64	+1	34	-65	25	-10	50	-11	50	+19
Massachusetts	76	77	+3	71	+17	53	+14	99	+6	99	+64
Nevada	47	56	--	33	--	24	--	83	--	26	--
New Mexico	52	66	--	45	--	43	--	52	--	43	--
North Carolina	73	83	+7	56	+2	47	-23	86	-13	49	-21
Puerto Rico	14	--	--	--	--	14	0	--	--	--	--
South Dakota	65	71	--	65	--	26	--	72	--	20	--
Texas	72	85	+3	60	-12	60	+7	99	0	72	0
Utah	79	83	+2	99	+83	44	+13	95	+56	53	+14
Vermont	55	56	--	61	--	41	--	55	--	11	--
West Virginia	75	75	--	54	--	60	--	99	--	75	--
Wyoming	59	63	--	30	--	35	--	74	--	20	--

NOTE: -- Data not available.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00 school year.

RACE/ETHNICITY OF K-12 STUDENTS

STATE	% White	% African-Amer.	% Hispanic	% Asian	% Am. Ind.
Arkansas	72.8	23.5	2.5	0.8	0.4
Connecticut	71.2	13.6	12.4	2.6	0.3
Idaho	87.1	0.7	9.7	1.2	1.2
Massachusetts	77.1	8.6	10.0	4.2	0.2
Nevada	61.2	9.9	22.0	5.1	1.8
New Mexico	37.2	2.3	48.8	1.0	10.8
North Carolina	62.5	31.2	3.1	1.7	1.5
Ohio	81.5	15.8	1.5	1.1	0.1
Puerto Rico	--	--	100.0	--	--
South Dakota	87.5	1.0	1.0	0.9	9.6
Texas	44.1	14.4	38.6	2.5	0.3
Utah	87.9	0.8	7.2	2.5	1.5
Vermont	97.1	0.9	0.4	1.0	0.5
West Virginia	94.9	4.2	0.5	0.3	0.1
Wyoming	88.6	1.0	6.7	0.8	2.9

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SOURCE: NCES, Common Core Data, Fall 1998.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC 2001.

National Trends. Data from national high school transcript studies conducted by NCES are useful for analyzing long-term national trends in math and science course-taking by student race/ethnicity and by student gender (Roey, et al., 2001). The national averages below show that since the 1980s minority students have made progress in participation in higher-level mathematics and science courses. We have selected Algebra 2 and Chemistry to trace minority students' progress as compared to that of white students.

The enrollment of African American students taking Algebra 2 increased significantly over the 1982 to 1998 period—from 26 percent to 52 percent of graduates. The white–African American gap in participation has narrowed by 5 percentage points over 16 years (to 10 points). Hispanic, African American, and American Indian students made the largest increases in Algebra 2 enrollments—with each group's enrollment doubling over 16 years.

In science, Chemistry enrollments increased significantly from 1982 to 1998 for all groups. African American and Hispanic enrollments in Chemistry more than doubled over 16 years—23 to 53 percent, 17 to 44 percent; white enrollments increased 28 percentage points, and Asian enrollments increased by 22 points.

- **As you study** Tables 17 and 18, consider the following questions about race/ethnic differences:

- What are the recent trends in course enrollments among minority groups in your state?
- How does your state compare with national trends?
- If you do not have these data by race/ethnicity, how could these data be obtained? Are these statistics important for your own work and to communicate where policy change is needed?

TABLE 18 **Race/Ethnic Trends for Students Taking Algebra 2 and Chemistry, 1982 to 1998**

STUDENTS TAKING ALGEBRA 2

Student Race/ Ethnicity	1982	1998
White	41	62
African American	26	52
Hispanic	23	45
Asian	55	62
American Indian	20	41

STUDENTS TAKING CHEMISTRY

Student Race/ Ethnicity	1982	1998
White	35	63
African American	23	53
Hispanic	17	44
Asian	52	74
American Indian	34	47

SOURCE: Roey, et al., 2001.

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Course Enrollments by Gender

- Female students had higher levels of enrollment in Algebra 2 and Chemistry (indicating three years of high school math and science) in all 22 states reporting by gender as of 2000.
- In 14 of 22 states, female enrollments increased by at least 2 percentage points in Trigonometry/Pre-calculus since 1990, and in 11 states female enrollments increased in Physics by 3 percentage points or more.

In analyzing course-taking trends by student gender since 1990, we focus on the higher levels of math and science. The data in Table 19 show trends by state on the percentage of females among students taking higher-level science, i.e., Chemistry and Physics (data on trends in math are also available). Contrary to some current views, and the patterns of the mid-1980s, now more high school girls take higher-level math and science courses than boys in all the reporting states (see detailed data in our web-based report, http://www.ccsso.org/SciMathIndicators01.html).

TABLE 19 **Gender Differences in Students Taking Science Courses, 1990 to 2000**

PERCENT FEMALE

	Chemistry		Physics	
STATE	% 2000	% Change 1990 to '00	% 2000	% Change 1990 to '00
Arkansas	56	+4	47	+4
California	53	+2	47	+5
Connecticut	52	+3	44	+8
Dist. of Columbia	55	-2	53	-10
DoDEA	54	+3	46	+6
Idaho	52	+1	38	+7
Iowa	54	+3	46	+6
Massachusetts	52	--	46	--
Nevada	51	0	45	+5
New Mexico	52	--	49	--
North Carolina	56	0	46	+1
North Dakota	52	--	40	--
Ohio	54	+2	43	+1
Oregon	52	--	43	--
Puerto Rico	53	+1	50	-4
South Dakota	53	--	45	--
Texas	53	--	49	--
Utah	51	+5	41	+8
Vermont	53	+2	46	+3
West Virginia	53	-1	31	-11
Wisconsin	54	+2	47	+7
Wyoming	52	+4	45	+9

NOTES: -- Data not available. Vermont: data includes imputation.
DoDEA, North Carolina, Ohio, Puerto Rico, Utah, Vermont: change from 1992 to 2000.

SOURCE: State Departments of Education, Data on Public Schools.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

Instructional Practices in Mathematics and Science

Policy Issues:

*** To what extent are teaching practices consistent with state content standards and national professional standards in mathematics and science?**

*** Are there major differences in instructional practices in mathematics and science across the states?**

*** Are differences in teaching practices related to higher student achievement in mathematics or science?**

The NCTM *Standards* for mathematics education (1989, 1991, 2000), the NRC *Science Education Standards* (1995), and the AAAS *Benchmarks* (1993) recommended approaches to instruction that increase students' direct involvement in learning through doing mathematics and science and constructing ways of reasoning and solving problems. Many states have completed their own state standards and curriculum frameworks in mathematics and science that suggest teaching strategies or provide examples of classroom practices that are consistent with challenging content standards (Blank, et al., 1997).

In the present report, we have selected data reported from the NAEP mathematics and science teacher surveys from the 2000 assessments to provide several indicators of variation in teaching practices across states. The percentages should be used with caution. These data are reported by teachers, and the questions are quite general and leave room for interpretation by respondents. The data may be useful for an initial picture of teaching practices. However, for meaningful analysis of achievement related to teaching at the classroom level, items would need to be placed in a scale with combinations of items and with additional classroom measures.

Mathematics Instructional Practices, Grades 4 and 8

Table 20 shows data by state on four instructional practices in mathematics in grade 4 classrooms. The state percentages for all four items—(a) Students discuss math problems in class with other students at least weekly, (b) Students write a few sentences about how to solve math problems at least weekly, (c) Students use calculators in math instruction weekly, and (d) Homework assigned per day in math—were reported by students.

Table 21 reports the same four instructional practices for grade 8 math classes. Data on calculator use is displayed by percentage using calculators daily and percentage using weekly. The state averages for all four practices show widely varied results.

- **Over 45 percent of grade 4 students "Discuss Solutions to Math Problems with Other Students" weekly or more in 12 states**, according to data in Table 20. At grade 8, 38 percent of students report they discuss math problems in class almost every day, and two-thirds discuss weekly. This indicator addresses the problem-solving and reasoning theme of the NCTM standards for mathematics education. Nationally, 42 percent of grade 4 students report discussing problems with other students at least weekly.

- **As of 2000, calculators were used in class weekly by 40 percent of grade 4 students.** In 1992, only 18 percent of grade 4 students across the United States reported using calculators in math class once per week or more, according to teacher reports. In 2000, seven states had over 50 percent of grade 4 students using calculators weekly or more often. By comparison, 45 percent of grade 8 students report they use calculators in math class almost

every day, and 70 percent use them at least once a week in class, which are significant increases from the early 1990s.

- **Forty percent of grade 8 students write about solving math problems weekly or more often.** Communication of mathematics is a process standard found in the national standards and most states. Two states have over 50 percent of grade 8 students writing about math problems weekly. At grade 4, 55 percent of students report they write about solving math problems once a week or more.

TABLE 20 Instructional Practices in Mathematics, Grade 4, 2000 NAEP

STATE	Students Discuss Math Problems % Once a Week or More	Write About Math Problems % Once a Week or More	Calculator Use % At Least Once a Week 2000	Calculator Use % At Least Once a Week 1992	Homework Assigned % 30 Minutes or More
Alabama	40	46	36	22	60
American Samoa	63	58	68	–	61
Arizona	45	50	42	15	49
Arkansas	37	63	45	8	54
California	47	51	42	34	56
Connecticut	45	61	43	29	49
District of Columbia	56	60	50	59	54
DDESS	45	63	39	–	52
DoDDS	45	61	42	–	51
Georgia	41	44	38	14	54
Guam	48	53	48	10	60
Hawaii	43	58	40	35	64
Idaho	32	49	34	28	48
Illinois	43	51	40	–	57
Indiana	43	48	36	12	57
Iowa	38	45	40	18	47
Kansas	37	52	43	–	47
Kentucky	37	51	43	47	57
Louisiana	42	70	56	18	52
Maine	43	56	46	23	50
Maryland	45	67	47	39	48
Massachusetts	50	69	38	18	50
Michigan	41	46	53	38	50
Minnesota	42	50	48	28	48
Mississippi	39	45	42	16	57
Missouri	40	52	38	14	49
Montana	34	47	39	–	45
Nebraska	37	43	39	22	51
Nevada	41	48	36	–	49
New Mexico	42	47	40	9	56
New York	46	68	32	14	49
North Carolina	43	57	56	21	58
North Dakota	29	42	37	14	45
Ohio	42	61	41	19	55
Oklahoma	33	39	36	8	51
Oregon	44	59	50	–	50
Rhode Island	49	78	61	18	46
South Carolina	43	59	38	15	51
Tennessee	43	47	40	7	55
Texas	40	50	33	24	57
Utah	40	45	44	21	46
Vermont	53	73	53	–	55
Virgin Islands	52	62	60	–	56
Virginia	38	46	39	14	52
West Virginia	34	52	40	24	57
Wyoming	41	58	42	24	52
NATION	42	55	40	18	50

NOTES: – Data not available.
Math Problems = When you do mathematics in school, how often do you talk to other students during class about how you solved mathematics problems? (student-reported); In mathematics class, how often do you write a few sentences about how you solved a mathematics problem? (student-reported).
Calculator Use = For mathematics, how often do you use a calculator for classwork? (student-reported).
Homework = About how much time do you usually spend each day on mathematics homework? (student-reported).

SOURCE: The Nation's Report Card, Mathematics 2000 (see for standard errors of estimates).
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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TABLE 21 Instructional Practices in Mathematics, Grade 8, 2000 NAEP

STATE	Students Discuss Math Problems % Almost Everyday	Write About Math Problems % Once a Week or More	Calculator Use % Almost Everyday 2000	Calculator Use % At Least Once a Week 2000	Calculator Use % At Least Once a Week 1992	Homework Assigned % 30 Minutes or More
Alabama	39	35	42	69	49	58
American Samoa	54	54	50	77	--	70
Arizona	35	32	36	63	49	63
Arkansas	42	44	46	70	42	58
California	42	46	39	63	56	71
Connecticut	38	42	43	74	53	59
District of Columbia	47	43	18	41	56	63
DDESS	44	54	37	69	--	66
DoDDS	44	45	63	89	--	66
Georgia	39	29	30	55	47	60
Guam	51	35	17	41	30	64
Hawaii	44	46	26	52	46	67
Idaho	40	32	50	75	69	54
Illinois	39	44	59	83	--	62
Indiana	39	30	36	63	41	59
Kansas	40	28	51	75	--	60
Kentucky	44	47	65	89	66	58
Louisiana	40	48	42	72	39	51
Maine	36	42	49	78	73	61
Maryland	38	49	42	70	49	59
Massachusetts	37	48	36	69	35	62
Michigan	40	42	61	81	68	59
Minnesota	36	46	75	94	75	50
Mississippi	40	31	38	59	31	54
Missouri	39	42	57	81	75	53
Montana	39	42	54	76	--	62
Nebraska	40	28	53	76	69	59
Nevada	36	32	34	59	--	63
New Mexico	39	31	35	56	46	62
New York	38	46	43	72	29	56
North Carolina	46	41	63	83	44	67
North Dakota	36	24	62	78	72	53
Ohio	36	31	25	53	52	57
Oklahoma	39	25	39	60	36	57
Oregon	37	51	64	91	--	58
Rhode Island	31	48	46	74	47	60
South Carolina	42	46	29	57	46	55
Tennessee	37	31	28	53	42	58
Texas	40	32	28	54	62	61
Utah	33	24	57	80	67	52
Vermont	39	52	44	76	--	61
Virginia	35	28	59	85	43	60
West Virginia	32	29	35	64	43	56
Wyoming	39	33	52	78	71	59
NATION	38	40	45	70	53	58

NOTES: – Data not available.
Math Problems = When you do mathematics in school, how often do you talk to other students during class about how you solved mathematics problems? (student-reported); In mathematics class, how often do you write a few sentences about how you solved a mathematics problem? (student-reported).
Calculator Use = For mathematics, how often do you use a calculator for classwork? (student-reported).
Homework = About how much time do you usually spend each day on mathematics homework? (student-reported).

SOURCE: The Nation's Report Card, Mathematics 2000 (see for standard errors of estimates).
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Science Instructional Practices in Middle Grades

The NAEP science assessments included teacher and student surveys. The data can be analyzed to produce indicators by state on instructional practices in science classrooms at grade 8. The results from the NAEP 2000 teacher survey provide basic information about the degree to which activities in eighth-grade science classes focus on hands-on, active learning. As with the math items on instruction, the questions are broad and the information does not address subject content taught or what knowledge or skills students are expected to learn. In Table 22, we report data on three measures of practices, which are from student reports.

- **Design Experiments/Investigations.** In about half of grade 8 science classes, students report they do design experiments or investigations in class, although only 15 percent nationally are designing experiments once a month or more. There are some differences in the rates among states, with Oregon, Vermont, and Massachusetts among those with slightly more activity. The data indicate that in half the science classes, students do not design any experiments or investigations at grade 8, or they are not aware they are doing so.

- **Discuss Results of Experiments/Investigations in Class.** Students report that they talk to their class about results of experiments or investigations in half the grade 8 science classes. In about one-fourth of students' classes, student presentations happen once or twice per month. The state percentages vary from 14 percent of students (e.g., Hawaii, Oklahoma) reporting monthly presentations to 30 percent of students (e.g., Michigan, Vermont).

- **Long-term Projects.** The third column in Table 22 shows the percentage of students in each state who report that they have done individual or group science projects or investigations in school that take a week or more. Two-thirds of students (66 percent), nationally, report doing a long-term science project at grade 8. The state percentages vary from 49 percent of students (e.g., Arkansas) to 83 percent of students (Maine).

TABLE 22 Instructional Practices in Science, Grade 8, 2000 NAEP

STATE	Design Experiment/ Investigation % Students: Yes, 1-2 Times/Month	Design Experiment/ Investigation % Students: Yes, Less Often	Discuss Results of Experiment/Investigation % Students: Yes, 1-2 Times/Month	Discuss Results of Experiment/Investigation % Students: Yes, Less Often	Long-Term Science Projects: % Students, Yes
Alabama	12	30	17	27	56
American Samoa	27	38	25	38	67
Arizona	17	34	23	30	70
Arkansas	10	28	13	26	49
California	16	35	24	31	70
Connecticut	17	37	28	30	76
DDESS	18	34	26	29	70
DoDDS	16	35	27	30	73
Georgia	15	33	21	31	69
Guam	18	45	21	37	69
Hawaii	11	24	14	22	61
Idaho	14	33	18	25	60
Illinois	15	39	25	32	74
Indiana	11	32	19	28	63
Kentucky	18	34	27	32	64
Louisiana	13	28	19	27	55
Maine	16	38	27	33	83
Maryland	15	36	27	32	69
Massachusetts	17	38	25	30	69
Michigan	18	38	30	29	66
Minnesota	11	36	20	29	71
Mississippi	14	31	21	27	55
Missouri	13	37	21	32	64
Montana	12	41	20	31	64
Nebraska	13	36	23	33	67
Nevada	16	36	23	28	66
New Mexico	14	38	20	31	63
New York	15	34	23	30	66
North Carolina	13	32	24	29	65
North Dakota	9	28	15	26	54
Ohio	12	39	24	31	66
Oklahoma	9	31	14	24	54
Oregon	17	46	21	34	76
Rhode Island	15	31	26	29	72
South Carolina	16	39	24	31	73
Tennessee	14	32	18	28	60
Texas	13	31	19	28	62
Utah	15	39	19	26	58
Vermont	17	41	30	36	82
Virginia	14	38	22	32	64
West Virginia	13	32	22	30	57
Wyoming	16	35	21	29	61
NATION	**15**	**34**	**22**	**29**	**66**

NOTES: *Long term* = Do you ever do science projects in school that take a week or more? (student-reported). *Talk to class* = About how often do you talk to the class about the results of your experiment or investigation? (student-reported). *Design Experiment* = About how often do you design your own experiment or investigation? (student-reported).

SOURCE: The Nation's Report Card: Science 2000 (see for standard errors of estimates).

Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

Chapter Three

Indicators of Teacher Preparation and Supply

Trends in Number of Teachers in Mathematics and Science
Certification in Assigned Field
Major in Assigned Field
Professional Development
Demographics of Current Teachers—Race/Ethnicity, Age, Gender
New Teachers

Policy Issues:
Indicators should inform educators, policymakers, and the public about conditions and trends concerning current teachers and the needs for improving the teaching force:

*** What proportion of current teachers have knowledge and teaching skills in their field at the level outlined by professional standards?**

*** Do we have a sufficient number of teachers currently, and are new teachers coming into math and science, which would allow us to improve the quality of teaching?**

*** What improvements in the knowledge and skills of teachers are needed? What efforts are currently being made to improve teachers' knowledge and skills?**

National professional standards in mathematics and science, as well as the standards in many states, call for change in teaching and classroom practices to emphasize active learning by students, deep understanding of concepts, and developing skills in problem-solving and reasoning (NCTM, 1989, 1991; AAAS, 1993; NRC, 1995; Blank, et al., 1997). The standards for teaching in mathematics and science de-emphasize teacher lectures, and encourage use of multiple strategies for teaching and learning. One implication of challenging state and local standards of learning for all students is a need for teachers with in-depth knowledge and understanding of their assigned field and skills in effective instructional methods for mathematics and science at their assigned grade level. Recent research confirms a strong positive relationship between the amount of teacher education and course-work preparation in math and science and the level of student achievement in these subjects (Darling-Hammond, 2000; Ferguson, et al.,1993; Fetler, 1999; Monk, 1994).

Issues of teacher preparation and teacher supply are critical for education quality in every state and the nation. The National Commission on Mathematics and Science Teaching for the 21st Century, called the "Glenn Commission," highlighted the current needs, set targets for quality teaching, and outlined a number of proposals for change to improve quality of teachers and teaching (USED, 2000). The report of the Glenn Commission set three main goals to guide action strategies:

- Establish an ongoing system to improve the quality of mathematics and science teaching in grades K-12;
- Increase significantly the number of mathematics and science teachers and improve the quality of their preparation;

- Improve the working environment and make the teaching profession more attractive for K-12 mathematics and science teachers.

The National Commission on Teaching & America's Future cited critical problems for education systems for the near future, including insufficient numbers of well-prepared teachers, shortages of teachers in urban areas and poorer communities that typically have difficulty attracting teachers, and impending retirements of a significant portion of our teaching force (1996). The commission recommended upgrades in the quality and consistency of data on teachers and teaching to assist in target problems and improvements.

The currently available state-by-state indicators regarding teachers and teaching provide basic information for addressing these issues. We use three primary sources for comparable state indicators for science and math teachers:

(1) State Education Information Systems—produce universe data on currently assigned teachers, state certification by assigned teaching field, teacher demographics, new teachers;
(2) Schools and Staffing Survey (SASS), conducted by National Center for Education Statistics—produces representative sample data on teacher preparation, class size;
(3) National Assessment on Educational Progress (NAEP), conducted by National Center for Education Statistics—produces representative sample data on teacher preparation, professional development.

Current Supply of Teachers

- ***Trends for All Math Teachers***: The total number of mathematics teachers in U.S. public high schools increased by over 22,000 from 1990 to 2000 (to 134,000). For grades 7-8, the number of teachers in math increased by 44,000 in six years from 1994 to 2000 (to 124,000). The total number of teachers of math and science increased during the 1990s in a majority of states, but numbers declined in several Midwest and Northeast states.
- ***Trends for All Science Teachers***: The total number of teachers of biology and chemistry increased by 4,700 teachers from 1990 to 2000. Teachers of physics increased by 1,800, and earth science teachers went up by 600. For grades 7-8, the number of science teachers increased by 27,000 from 1994 to 2000 (to 93,000).
- ***Trends for Teachers with Main Assignment in Math/Science***: Teachers with their main assignment in math or science have increased rapidly over the decade. High school teachers with main assignment in math increased from 61,000 to 71,000 during the 1990s, while teachers with main assignment in science increased from 51,000 to 65,000 in the decade.

Tables 23 through 26 show the change in size of the total mathematics and science teaching force during the 1990s. The statistics for each state and the nation in Tables 23 and 24 represent the total number of teachers in each subject, i.e., teachers assigned one or more period/class in the subject. Tables 25 and 26 show the trends in teachers with their main or primary assignment (more than 50 percent of time) in mathematics or in science fields.

High School Teachers. There are notable changes in the size of the teaching force in several states, but also major differences according to which method of counting is used. For example, in high school mathematics teaching, Texas more than doubled the number of teachers (9,800 to 24,100), and North Carolina increased numbers by over a thousand teachers. However, in 11 states (mostly Midwest and Northeast states), the number of math teachers declined during the 1990s.

In high school science, the numbers of teachers have increased in all four fields reported in Table 23. The numbers of teachers assigned in science increased the most in biology and chemistry (over 10 percent). In middle grades science, the numbers have declined in a dozen states with substantial increases of science teachers in California, Connecticut, Massachusetts, Minnesota, North Carolina, Texas, and Utah.

Change in numbers can be partly explained by increasing use of multiple assignments for teachers or part-time teachers. For example, in Texas only 32 percent of the total high school teachers assigned in math have their main assignment in math (7,900 teachers), and the total went up by only 400 teachers over 10 years. Nationally, only 53 percent of the total number of teachers of high school mathematics have their main assignment in the field.

Middle Grades Teachers. The data in Table 24 data show that several states rapidly increased the number of middle grades teachers in math and science (main or other assignment), particularly California, Connecticut, Massachusetts, Minnesota, North Carolina, Texas, Utah, and Wisconsin, but 13 of the states with trend data have fewer middle grades math teachers in 2000 than in 1990, and 13 states also have fewer teachers of science. The number of middle grades teachers with main assignment in math went up more than the high school total.

(Details on teachers by assignment are available on the CCSSO website: http://www.ccsso.org/SciMathIndicators01.html).

➢ **As you study** Tables 23-26, consider the following questions:

- What are the ten-year trends for your state in total numbers of math and science teachers, and teachers with main assignment in the field? How do trends compare with other states in your region?
- Do you know what accounts for trends in current numbers of teachers in your state?
- What is the extent of unmet needs for teachers? Do you have any other data indicating the demand for teachers vs. these current teacher figures (i.e., data on positions not filled or courses not offered due to teacher shortages)?
- Are there problems in data collection for your state that prevent having reliable, consistent data on math and science teachers?

TABLE 23 All Teachers in Mathematics and Science, Grades 9-12, 2000; Change 1990 to 2000

	MATH		BIOLOGY		CHEMISTRY		PHYSICS		EARTH SCIENCE	
		Change		Change		Change		Change		Change
STATE	2000	1990 to '00	2000	1990 to '00	2000	1990 to '00	2000	1990 to '00	2000	1990 to '00
Alabama	1,955	+358	984	+175	421	+41	214	-91	154	+136
Alaska	--	--	--	--	--	--	--	--	--	--
Arizona	--	--	--	--	--	--	--	--	--	--
Arkansas	1,311	+661	421	-97	208	-75	95	-125	0	-91
California	10,562	+878	3,861	+128	1,854	+546	1,133	+265	617	+1
Colorado	1,460	+163	1,366	+205	--	--	--	--	--	--
Connecticut	1,831	+378	849	+229	454	+81	261	+18	281	+23
Delaware	--	--	--	--	--	--	--	--	--	--
Dist. of Columbia	--	--	--	--	--	--	--	--	--	--
DoDEA	--	--	--	--	--	--	--	--	--	--
Florida	5,201	--	1,840	-1,992	748	-348	448	-184	728	-1,280
Georgia	3,061	--	1,295	--	--	--	--	--	--	--
Hawaii	--	--	--	--	--	--	--	--	--	--
Idaho	856	+207	307	+37	142	+13	102	-2	161	+56
Illinois	--	--	--	--	--	--	--	--	--	--
Indiana	2,542	+244	1,155	+152	640	+149	411	+43	406	+123
Iowa	1,389	-98	634	-86	425	-2	357	-33	214	-120
Kansas	1,531	+352	698	+45	439	+69	324	+62	91	+9
Kentucky	1,601	-58	701	+12	423	+78	217	-3	159	+116
Louisiana	1,339	-2,226	539	-277	208	-234	88	-153	44	-64
Maine	667	-129	336	-21	208	+5	161	-12	153	-21
Maryland	--	--	--	--	--	--	--	--	--	--
Massachusetts	2,980	-533	1,246	+482	756	+290	473	+204	274	-49
Michigan	2,384	-955	547	-292	270	-164	157	-104	97	-33*
Minnesota	2,054	+243	862	+147	523	+48	360	-6	120	-2
Mississippi	1,187	+468	767	+369	298	+157	206	+160	101	+100
Missouri	2,341	+342	1,307	+321	665	+91	428	+67	203	+36
Montana	--	--	--	--	--	--	--	--	--	--
Nebraska	1,237	--	571	--	330	--	283	--	244	--
Nevada	562	-111	247	+34	118	+49	68	+27	105	+17
New Hampshire	759	+159	300	+72	93	+34	49	+17	44	+10
New Jersey	4,566	+191	1,409	+522	781	+444	379	+297	433	+61
New Mexico	--	--	--	--	--	--	--	--	--	--
New York	8,406	+553	5,445	+265	2,182	+318	1,294	+136	3,392	+461
North Carolina	3,976	+1,010	1,434	+253	663	+110	352	+21	795	+624
North Dakota	509	+38	273	+11	177	+3	119	-6	13	+4
Ohio	3,645	-609	1,511	-184	935	-50	627	-124	347	-47
Oklahoma	2,019	+345	1,118	+217	508	+27	246	+6	95	+9
Oregon	1,067	-155	317	-21	--	--	--	--	--	--
Pennsylvania	--	--	--	--	--	--	--	--	--	--
Puerto Rico	2,926	+1,344*	588	+174*	366	+135*	259	+140*	32	-62*
Rhode Island	422	+4	175	+20	92	+15	63	+19	4	-6
South Carolina	--	--	--	--	--	--	--	--	--	--
South Dakota	481	-226	255	+25	188	+37	132	+7	43	+17
Tennessee	2,033	+161	866	+157	342	-15	174	-64	64	+25
Texas	24,103	+14,269	5,573	+1,622	2,989	+1,427	1,704	+795	726	+360
Utah	692	-422	326	-179	180	+75	162	+93	92	-17
Vermont	379	+101*	158	+31*	111	+31*	86	+13*	86	+9*
Virgin Islands	--	--	--	--	--	--	--	--	--	--
Virginia	--	--	--	--	--	--	--	--	--	--
Washington	--	--	--	--	--	--	--	--	--	--
West Virginia	1,129	+223	239	-147	170	-12	104	-18	130	+63
Wisconsin	2,412	+452	1,089	+251	623	+101	405	+31	160	+47
Wyoming	265	-199	125	-55	64	-61	46	-52	26	-68
NATION	133,945	+22,761	51,048	+4,771	25,931	+4,735	15,853	+1,783	14,057	+632

NOTES: -- Data not available.
All Teachers = one or more period assigned to subject.
* = change 1992 to 2000.
Colorado: 1990, 2000 biology = all science; Arkansas: 1990 math = main assignment only; New Jersey: 2000 grades 7-12, 1990 main assignment only; Rhode Island: 1990 main assignment only; Vermont: data includes imputation.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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TABLE 24 All Teachers in Mathematics and Science, Grades 7-8, 2000; Change 1994 to 2000

STATE	NUMBER OF MATH TEACHERS		NUMBER OF SCIENCE TEACHERS	
	2000	Change 1994 to '00	2000	Change 1994 to '00
Alabama	1,288	-86	1,162	-81
Alaska	--	--	--	--
Arizona	--	--	--	--
Arkansas	--	--	--	--
California	7,838	+203	6,723	+1,165
Colorado	893	-178	787	-214
Connecticut	1,214	+286	1,013	+190
Delaware	--	--	--	--
Dist. of Columbia	--	--	--	--
DoDEA	--	--	--	--
Florida	--	--	--	--
Georgia	1,441	--	1,099	--
Hawaii	--	--	--	--
Idaho	430	+34	386	+40
Illinois	--	--	--	--
Indiana	1,521	-14	1,381	-49
Iowa	--	--	--	--
Kansas	388	--	923	--
Kentucky	1,048	-111	951	-56
Louisiana	439	-83	456	-37
Maine	460	-3*	388	+110*
Maryland	--	--	--	--
Massachusetts	2,419	+849	2,310	+832
Michigan	1,549	--	1,243	--
Minnesota	992	+196	961	+229
Mississippi	877	-74	801	-35
Missouri	1,443	+109	1,391	+103
Montana	--	--	--	--
Nebraska	148	-64	143	-51
Nevada	388	+78	301	+69
New Hampshire	109	+6	--	--
New Jersey	598	-1,918	84	-1,424
New Mexico	--	--	--	--
New York	6,600	-364	4,816	-665
North Carolina	3,441	+662	2,816	+324
North Dakota	434	-36	364	-17
Ohio	2,720	-67	2,375	0
Oklahoma	1,332	+147	1,251	+151
Oregon	434	-233	414	-83
Pennsylvania	--	--	--	--
Puerto Rico	2,036	+523	1,253	+457
Rhode Island	240	-4	226	-6
South Carolina	--	--	--	--
South Dakota	352	+14	309	-10
Tennessee	1,145	-331*	1,237	-243*
Texas	38,935	+30,109	23,403	+17,207
Utah	643	+350	527	+276
Vermont	304	+38	265	+30
Virgin Islands	--	--	--	--
Virginia	--	--	--	--
Washington	--	--	--	--
West Virginia	880	+79	693	+157
Wisconsin	1,323	+273	1,188	+189
Wyoming	157	-74	149	-50
NATION	**124,864**	**+43,898**	**92,912**	**+27,889**

NOTES: -- Data not available. Oregon: includes grade 6; Vermont: data includes imputation. All Teachers = one or more period assigned to subject.
* = change 1996 to 2000.

SOURCE: State Departments of Education; Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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TABLE 25 Teachers with Main Assignment in Mathematics and Science, Grades 9-12, 2000; Change 1990 to 2000

	MAIN ASSIGNMENT			
	Math		Science	
STATE	2000	Change 1990 to '00	2000	Change 1990 to '00
Alabama	1,722	+476	1,245	+261
Alaska	--	--	--	--
Arizona	--	--	--	--
Arkansas	--	--	--	--
California	8,641	+2,056	6,613	+2,302
Colorado	1,399	+232	1,316	--
Connecticut	1,487	+107	1,280	+25
Delaware	--	--	--	--
Dist. of Columbia	--	--	--	--
DoDEA	--	--	--	--
Florida	4,418	--	3,792	--
Georgia	2,981	--	2,713	--
Hawaii	--	--	--	--
Idaho	481	+27	352	+92
Illinois	--	--	--	--
Indiana	2,249	--	1,923	--
Iowa	--	--	--	--
Kansas	--	--	--	--
Kentucky	1,340	-20	902	+189
Louisiana	1,222	--	869	--
Maine	--	--	--	--
Maryland	--	--	--	--
Massachusetts	2,652	--	2,786	--
Michigan	2,262	-776	2,197	-240
Minnesota	1,654	+350	1,330	+289
Mississippi	1,028	+381	853	+409
Missouri	2,005	+286	1,772	+363
Montana	--	--	--	--
Nebraska	1,063	--	683	--
Nevada	533	+22	510	+198
New Hampshire	--	--	--	--
New Jersey	3,878	--	3,201	--
New Mexico	--	--	--	--
New York	6,794	+1,061	10,594	+1,645
North Carolina	2,657	-12	2,173	-658
North Dakota	335	+24	204	+63
Ohio	3,454	-375	2,883	-230
Oklahoma	1,876	+386	1,365	+294
Oregon	--	--	--	--
Pennsylvania	--	--	--	--
Puerto Rico	1,922	+997	1,336	--
Rhode Island	422	--	503	--
South Carolina	--	--	--	--
South Dakota	347	-105	195	+14
Tennessee	--	--	--	--
Texas	7,892	+418	6,630	+1,495
Utah	614	-155	527	-34
Vermont	325	--	342	--
Virgin Islands	--	--	--	--
Virginia	--	--	--	--
Washington	--	--	--	--
West Virginia	1,109	--	1,454	--
Wisconsin	2,224	+558	2,125	+779
Wyoming	240	-99	236	-61
NATION	71,226	+10,331	64,904	+13,528

NOTES: -- Data not available; Main Assignment = 50% or more time assigned to subject. Science = sum biology, chemistry, physics, earth science, physical science, general science, integrated science (2000). New Jersey: grades 7-12; Vermont: 2000 data includes imputation.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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TABLE 26 Teachers with Main Assignment in Mathematics and Science, Grades 7-8, 2000; Change 1992 to 2000

	MAIN ASSIGNMENT			
	Math		Science	
STATE	2000	Change 1992 to '00	2000	Change 1992 to '00
Alabama	1,018	+243	934	+215
Alaska	–	–	–	–
Arizona	–	–	–	–
Arkansas	–	–	–	–
California	5,509	+1,502	5,070	+1,888
Colorado	794	+10	705	-35
Connecticut	789	+124	761	+112
Delaware	–	–	–	–
Dist. of Columbia	–	–	–	–
DoDEA	–	–	–	–
Florida	–	–	–	–
Georgia	1,332	–	1,027	–
Hawaii	–	–	–	–
Idaho	201	-2	228	+46
Illinois	–	–	–	–
Indiana	1,269	+36	1,184	+37
Iowa	–	–	–	–
Kansas	–	–	–	–
Kentucky	767	-53	737	+2
Louisiana	347	–	369	–
Maine	–	–	–	–
Maryland	–	–	–	–
Massachusetts	2,048	–	2,022	–
Michigan	1,459	-162	1,190	-294
Minnesota	664	+86	720	+180
Mississippi	670	-36	585	+19
Missouri	1,085	+153	1,116	+201
Montana	–	–	–	–
Nebraska	144	–	140	–
Nevada	367	+115	285	+137
New Hampshire	–	–	–	–
New Jersey	–	–	–	–
New Mexico	–	–	–	–
New York	4,791	+1,501	3,618	-42
North Carolina	851	-508	1,200	-39
North Dakota	260	+136	141	+31
Ohio	2,409	+460	2,141	+387
Oklahoma	724	+79	720	+134
Oregon	–	–	–	–
Pennsylvania	–	–	–	–
Puerto Rico	1,570	+483	1,081	+445
Rhode Island	240	+13	226	+13
South Carolina	–	–	–	–
South Dakota	133	-14	143	+3
Tennessee	–	–	–	–
Texas	14,568	+10,651	11,139	+7,292
Utah	581	+377	494	+349
Vermont	220	–	216	–
Virgin Islands	–	–	–	–
Virginia	–	–	–	–
Washington	–	–	–	–
West Virginia	855	+399	678	+408
Wisconsin	1,124	–	1,013	–
Wyoming	128	-59	117	-44
NATION	46,917	+13,307	40,000	+7,896

NOTES: – Data not available; Main Assignment = 50% or more time assigned to subject.
Vermont: 2000 data includes imputation.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Teachers Certified in Assigned Field

State certification in the assigned teaching field indicates that teachers have a basic level of preparation in the subject they are teaching. Using teacher personnel files and teacher assignment data, states reported the number of teachers of high school mathematics and science who are certified. The proportion of teachers who are certified in the subjects they are teaching is an important policy indicator for state and local educators because state certification is often used as a basic measure of teacher qualification and as an indicator of teacher supply and shortage. It is not, however, an adequate measure of quality of teacher preparation, particularly in cross-state comparisons, because of the differing state standards for certification. State certification requirements are tracked by CCSSO every two years for secondary, middle grades, and elementary teachers, and they are reported in *Key State Education Policies on K-12 Education* (CCSSO, 2000a, http://www.ccsso.org/pdfs/keystate2000.pdf).

In the following analysis, "certification" in a field means the teacher holds a state's regular, standard, advanced, or probationary certificate in the assigned field/subject. In science, the teacher holds a "specific-field" certification (e.g., biology) or a "broad-field" certification (multiple fields of science). "Not certified" means the teacher holds an emergency or temporary certificate or holds a certification in a field other than the assigned field.

High School Teachers Certified in Field

- **The state statistics for the 1999-2000 school year show widely divergent patterns of certified teachers across the states. In Table 27, half the states have over 95 percent of high school teachers certified in the field of assignment. But seven states have more than 10 percent of teachers uncertified in mathematics and one or more science fields of biology, chemistry, physics, and earth science.**
- **From 1990 to 2000, the national percentage of high school mathematics teachers certified in their field declined from 90 percent to 86 percent, and certification rates in science declined slightly in each of four fields. It should be noted, however, that in the same period the number of high school teachers of mathematics went up over 20 percent and the number of high school teachers of science increased more than 10 percent.**

There are several explanations for wide differences in certification of high school teachers across states. One explanation is rapid growth in enrollment, which translates to increases in students taking courses, and subsequent growth in the teaching force. For example, 10 states have fewer than 90 percent of current high school science or math teachers that are certified, and several of the states in this group have recent population growth, including Louisiana, North Carolina, and Texas.

Another explanation for differences in certification rates among states lies in the different levels of course-taking required for licensure and certification in a specific field of teaching. Darling-Hammond (2000) found that state requirements for licensure vary widely, with some states, such as Wisconsin, California, and Maine, holding high standards, including course credit requirements in the teaching field, credit hours of preservice experience, and acceptable scores

TABLE 27 Certification of Grades 9-12 Mathematics and Science Teachers, 2000; Change 1990 to 2000

STATE	Mathematics		Biology		Chemistry		Physics		Earth Science
	% Cert. 2000	Change 1990 to '00	% Cert. 2000	Change 1990 to '00	% Cert. 2000	Change 1990 to '00	% Cert. 2000	Change 1990 to '00	% Cert. 2000
Alabama	94	-1	95	-3	96	+3	98	+21	93
Alaska	–	–	–	–	–	–	–	–	–
Arizona	–	–	–	–	–	–	–	–	–
Arkansas	–	–	–	–	–	–	–	–	–
California	93	+12	89	+5	86	+3	91	+7	66
Colorado	–	–	–	–	–	–	–	–	–
Connecticut	97	-3	95	-5	91	-9	89	-11	78
Delaware	–	–	–	–	–	–	–	–	–
Dist. of Columbia	–	–	–	–	–	–	–	–	–
DoDEA	–	–	–	–	–	–	–	–	–
Florida	–	–	–	–	–	–	–	–	–
Georgia	89	–	90	–	–	–	–	–	–
Hawaii	–	–	–	–	–	–	–	–	–
Idaho	54	–	99	0	99	+2	97	+1	70
Illinois	–	–	–	–	–	–	–	–	–
Indiana	95	-1*	98	+2*	99	+5*	97	+11*	95
Iowa	–	–	–	–	–	–	–	–	–
Kansas	–	–	–	–	–	–	–	–	–
Kentucky	94	+5	97	-2	99	+3	96	+9	90
Louisiana	82	–	85	–	75	–	67	–	64
Maine	–	–	–	–	–	–	–	–	–
Maryland	–	–	–	–	–	–	–	–	–
Massachusetts	86	–	91	–	95	–	92	–	95
Michigan	96	–	91	–	83	–	55	–	59
Minnesota	88	-9	92	-5	83	-7	81	-9	37
Mississippi	85	-8	81	-8	66	-7	47	-1	84
Missouri	81	-18	70	-27	68	-26	60	-25	43
Montana	–	–	–	–	–	–	–	–	–
Nebraska	89	–	88	–	78	–	66	–	64
Nevada	96	+13	94	-4	39	-61	25	-73	26
New Hampshire	–	–	–	–	–	–	–	–	–
New Jersey	100	0	–	–	–	–	–	–	–
New Mexico	–	–	–	–	–	–	–	–	–
New York	–	–	–	–	–	–	–	–	–
North Carolina	86	-9	90	-7	93	-7	86	-10	82
North Dakota	90	-10	100	0	100	0	100	0	100
Ohio	99	+1	94	-5	96	-3	94	-5	76
Oklahoma	100	+6	100	+3	100	+5	100	+15	100
Oregon	–	–	–	–	–	–	–	–	–
Pennsylvania	–	–	–	–	–	–	–	–	–
Puerto Rico	90	–	99	–	95	–	98	–	94
Rhode Island	100	0	100	0	100	0	100	0	100
South Carolina	–	–	–	–	–	–	–	–	–
South Dakota	99	+51	100	+25	99	+45	100	+61	100
Tennessee	–	–	–	–	–	–	–	–	–
Texas	74	–	73	–	80	–	78	–	63
Utah	90	-4	91	+2	88	-8	83	-11	51
Vermont	96	-1*	97	–	98	–	97	–	97
Virgin Islands	–	–	–	–	–	–	–	–	–
Virginia	–	–	–	–	–	–	–	–	–
Washington	–	–	–	–	–	–	–	–	–
West Virginia	100	+4*	100	+6*	100	+10*	100	+12*	100
Wisconsin	100	–	100	–	100	–	100	–	100
Wyoming	100	–	100	–	100	–	100	–	100
NATION	**86**	**-4**	**88**	**-4**	**88**	**-4**	**85**	**-3**	**82**

NOTES: – Data not available. * = Change 1992 to 2000. Certified = Teachers assigned one or more period to subject who have state certification in subject. Science Certified = specific-field or broad-field certification. Idaho: Math = main assignment only; New Jersey: grades 7-12; Oklahoma: Gen. Sec. = alternative schools; Vermont: data includes imputation.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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on teacher assessments. Other states, such as Louisiana, South Dakota, and New Mexico, set lower requirements that make certification in math or science fields relatively easier. It is also possible in many states for districts to use endorsement policies or waivers to increase rates of certification for specific fields (NASDTEC Manual, 2001).

Mathematics. Several states report 100 percent of math teachers as certified in the field, including New Jersey, Oklahoma, Rhode Island, Wisconsin, and Wyoming, and several states are very close to 100 percent (Ohio, South Dakota). These high rates raise questions about data accuracy and completeness (e.g., are all teachers of math included in the state-reported data. CCSSO does ask each state to verify accuracy and completeness). A number of states have current shortages of certified math teachers, and the rates have declined slightly nationally.

Biology, Chemistry, Physics, Earth Science. Ten of the reporting states have over 95 percent of teachers certified in field in biology and chemistry. The certification rate includes teachers certified in the specific field as well as "broad-field" science certification, where applicable (see *Key State Policies* tables). The states of California, Georgia, Louisiana, Mississippi, and Texas have shortages in well-prepared science teachers in high schools. The national average for certified teachers in biology (88 percent in 2000) shows decline of 4 percentage points over ten years from 1990 to 2000; the chemistry rate (88 percent) shows decline of 4 points; and the physics rate (85 percent) is a decline of 3 points. Currently there are severe shortages of certified teachers in earth science with only 82 percent of teachers across the nation being certified.

High School Teachers Certified in Assigned Field: Nation 1990 to 2000

	Math	Biology	Chemistry	Physics	Earth Science
1990	90%	92%	92%	88%	n.a.
1994	88	90	92	86	81
1998	88	86	89	86	68
2000	86	88	88	85	82

Source: State Departments of Education, 1990 - 2000.

Broad-field Science Certification. Two-thirds of the states have a certification for broad-field secondary science certification that covers teaching in biology, chemistry, physics, and other science subjects. Most states also have certification in the specific fields of biology, chemistry, physics, etc. (See Key State Policies tables).

Our analysis of state data by type of science certification revealed that almost one-third of all high school science teachers are certified through a broad-field certification. Many schools must hire teachers to teach two or three science subjects, and they tend to hire teachers who have received state certification through a broad-field, or "non-specialist," method of science certification.

Middle-Level Teachers Certified in Field

- **As of 2000, 66 percent of middle grades mathematics teachers in the United States were certified in mathematics, as shown in Table 28. This figure indicates a gain of 12 percentage points over the certification rate as of 1994. Nationally, 15 percent of middle-level math teachers in 2000 were certified with elementary certification, and 19 percent of all math teachers were not certified.**
- **In science, very similar rates of certification are found, with 68 percent of science teachers certified in science, 12 percent elementary certified, and 20 percent of all science teachers not certified in 2000.**

Many states find that indicators of middle school science and mathematics teachers are key statistics. First, middle grades classes are often where students develop strong interests and aspirations in science and mathematics, or where interests fall off. Second, middle grades are often where states, districts, and schools find it is difficult to fill positions with well-qualified teachers in science and mathematics. States reported on the total number assigned to each subject, and then differentiated between teachers assigned to grades 7-8 math and science who are certified in elementary education and those certified in math or science.

Grade 7-8 Mathematics and Science

Table 28 shows that of the 28 states reporting certification data for grade 7-8 teachers, only seven states have 90 percent or more of their middle grades teachers certified in math. Only 11 have more than 80 percent certified, while 17 are below 80 percent certified in math.

Only six of the 28 states reporting data on middle grades science teachers have 90 percent or more certified middle school science teachers. Only one more state has at least 80 percent certified in science, and 21 states have less than 80 percent certified in field. A large group of states have more than 50 percent of science teachers who are elementary-certified.

Middle Grades 7-8 Teachers Certified in Assigned Field: Nation 1996 to 2000

	Cert. Math	Cert. Elem	Cert. Sci	Cert. Elem
1996	65%	16%	63%	19%
1998	72	5	73	5
2000	66	15	68	12

Source: State Departments of Education, 1996 - 2000.

- **As you study** Tables 27 and 28 on teacher certification, consider these questions:

- Do these data accurately reflect what you know about the rate of certification of teachers of math and science in your state?
- If your state is not reported, are these important data for your state, either as a trend or as a one-time status figure?
- What are the reasons for state totals on teacher assignment by certification status not being reported or available?

- How do the rates of certification of teachers differ across school districts—central city vs. suburb vs. rural? Large schools vs. small schools?
- Is the rate of certification a valid indicator of the quality of preparation of teachers for your state?

TABLE 28 Certification of Mathematics and Science Teachers, Grades 7-8, 2000; Change 1994 to 2000

	MATHEMATICS				SCIENCE			
STATE	Certified Math	Change Certified Math 1994 to '00	Certified Elementary	Not Certified	Certified Science	Change Certified Science 1994 to '00	Certified Elementary	Not Certified
Alabama	72	-7*	28	1	77	-3*	20	2
Alaska	--	--	--	--	--	--	--	--
Arizona	--	--	--	--	--	--	--	--
Arkansas	--	--	--	--	--	--	--	--
California	55	+10	36	9	59	-2	33	8
Colorado	--	--	--	--	--	--	--	--
Connecticut	40	-8	57	4	45	-14	52	3
Delaware	--	--	--	--	--	--	--	--
Dist. of Columbia	--	--	--	--	--	--	--	--
DoDEA	--	--	--	--	--	--	--	--
Florida	--	--	--	--	--	--	--	--
Georgia	16	--	78	6	18	--	73	8
Hawaii	--	--	--	--	--	--	--	--
Idaho	25	--	23	2	65	-9	32	3
Illinois	--	--	--	--	--	--	--	--
Indiana	88	+1	8	5	92	0	4	4
Iowa	--	--	--	--	--	--	--	--
Kansas	--	--	--	--	--	--	--	--
Kentucky	67	+37	32	1	61	+35	38	1
Louisiana	84	-2	0	16	77	-2	0	23
Maine	--	--	--	--	--	--	--	--
Maryland	--	--	--	--	--	--	--	--
Massachusetts	49	-18	41	10	51	-19	40	9
Michigan	69	--	--	--	60	--	--	--
Minnesota	91	-5	0	9	73	-7	0	27
Mississippi	34	-3	65	1	44	-8	55	0.5
Missouri	62	-26	0	38	52	-29	0	48
Montana	--	--	--	--	--	--	--	--
Nebraska	92	0	8	0	73	-3	27	0
Nevada	43	-13	56	1	57	+9	41	1
New Hampshire	--	--	--	--	--	--	--	--
New Jersey	--	--	--	--	--	--	--	--
New Mexico	--	--	--	--	--	--	--	--
New York	--	--	--	--	--	--	--	--
North Carolina	65	-3	2	33	59	-9	1	40
North Dakota	57	-1	43	0	65	-5	35	0
Ohio	40	-11	53	7	37	-1	59	6
Oklahoma	47	-7	53	0	59	-8	41	0
Oregon	--	--	--	--	--	--	--	--
Pennsylvania	--	--	--	--	--	--	--	--
Puerto Rico	84	0	0	16	98	-1	0	2
Rhode Island	100	0	0	0	100	0	0	0
South Carolina	--	--	--	--	--	--	--	--
South Dakota	93	-4	7	0	88	-4	12	0
Tennessee	--	--	--	--	--	--	--	--
Texas	68	+45	0	32	68	+13	0	32
Utah	90	+7	0	10	76	+4	0	24
Vermont	45	--	52	4	47	--	48	5
Virgin Islands	--	--	--	--	--	--	--	--
Virginia	--	--	--	--	--	--	--	--
Washington	--	--	--	--	--	--	--	--
West Virginia	100	--	0	0	100	--	0	0
Wisconsin	100	--	0	0	100	--	0	0
Wyoming	89	+15	11	0	93	+18	7	0
NATION	**66**	**+12**	**15**	**19**	**68**	**+5**	**12**	**20**

NOTES: -- Data not available. * = Change 1996 to 2000. Certified math (science) = Teachers assigned one or more period to subject who have state certification in secondary math (science) or middle level math (science). Certified Elementary = Certification in Elementary Education, General Secondary/Middle, or subject not assigned. Idaho: math teachers assigned less than 50% only; Oklahoma: Gen. Sec. = alternative schools; Texas: % not certified includes elem./middle; Vermont: data includes imputation.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Teachers with a Major in Assigned Field

A second important state-by-state indicator of the preparation of teachers in their assigned teaching field of science or mathematics is the percentage of teachers who earned a major in the field in an undergraduate or graduate degree. A major in the teaching field is a relatively consistent and comparable measure of the extent of teachers' knowledge of the subject. Teacher knowledge of subject is a key to effective teaching, along with understanding of how students learn and teaching methods (Darling-Hammond, 1996). Research has shown a positive relationship between the amount of course-work preparation of teachers in science and mathematics and student learning in those fields (Shavelson et al., 1989). Data from the Longitudinal Study of American Youth showed that each additional mathematics course taken by mathematics teachers above the average for teachers translates into 2 percent to 4 percent higher student achievement (Monk, 1994). The National Commission on Teaching & America's Future (1996) documented the fact that inequity in proportion of teachers with a major in their field shows major differences by school location and socioeconomic status of students, and the pattern of variation in prepared teachers is a major source of inequity in our schools.

Grade 8 Math and Science Teachers with Major in Field

- **NAEP 2000 results reveal that 44 percent of grade 8 math teachers had an undergraduate major in mathematics and 27 percent majored in math education. The percentages show little change from 1996.**
- **NAEP 2000 science results indicate that 35 percent of grade 8 teachers had an undergraduate major in science education, and 39 percent majored in a life science field, 20 percent in physical science, and 19 percent in earth science.**

The data shown in Tables 29 (math) and 30 (science) are from surveys of teachers of students taking the NAEP math and science assessments. The statistics are based on a representative sample of students in each state. We report the state percentages of teachers with a major in math vs. math education (and science vs. science education) separately because (a) teacher respondents may have majored in both math and math education (a common pattern in some states and higher education institutions); and (b) some states encourage or require a major in the subject while others encourage a major in education specializing in the subject. We did not analyze the data by teacher or classroom in order to determine the percentage of teachers with a major in subject field and in education. Thus, it is not appropriate to sum the percentages for the two types of major for each state.

Math. The state percentages of grade 8 teachers with a major in *Mathematics* vary from 22 percent to 69 percent of all math teachers at this grade level. The percentages of teachers with a major in *Math Education* vary by state from 15 percent to 65 percent. If we assumed (probably incorrectly) that teachers majored in math OR math education, the best-case position is that a national average of 71 percent of teachers at grade 8 have an undergraduate major in math or math education. Even with this best-case assumption about summing majors, several states would have less than half the grade 8 math teachers with a major in the assigned field. (Note: It is likely that a small percentage of teachers majored in their assigned field of math or science only in graduate school, and these additional percentages are available with further analysis of NAEP results.)

Science. In Table 30, the state percentages of grade 8 teachers with a major in a science field, such *as Life Science*, vary from 16 percent (Louisiana) to 71 percent (Minnesota), or in *Physical Science*, from 11 percent (North Carolina) to 46 percent (Utah). The percentages of teachers with a major in *Science Education* vary by state from 17 percent to 68 percent. If we assumed that teachers majored in science education OR one of the science fields (probably incorrectly), the best-case position is that a national average of 74 percent of teachers at grade 8 have an undergraduate major in a science field or science education. Again, it is also likely that a portion of teachers in each have a double major including science education.

[Note: CCSSO will report state-level averages from the SASS 2000 public school teachers survey on grade 7-12 math and science teachers with major or minor in assigned fields (as we reported in prior editions of the Science-Math Indicators series). However, the 2000 SASS survey data are not available as of publication date. The data will be reported on-line when available.]

TABLE 29 Mathematics Teachers, Grade 8, with Major in Assigned Field, 1996 to 2000

	MATH TEACHERS, GRADE 8			
	% with Major in MATH, Undergrad.		% with Major in MATH EDUCATION, Undergrad.	
STATE	2000	1996	2000	1996
Alabama	53	54	42	28
Alaska	–	47	–	16
American Samoa	63	–	13	–
Arizona	33	32	21	18
Arkansas	55	47	38	36
California	48	43	17	8
Colorado	–	54	–	28
Connecticut	50	48	17	17
Delaware	–	28	–	34
District of Columbia	54	61	31	20
DDESS	45	34	36	46
DoDDS	54	43	25	28
Florida	–	42	–	34
Georgia	30	33	35	28
Guam	61	34	29	*
Hawaii	43	46	34	40
Idaho	43	–	31	–
Illinois	48	–	34	–
Indiana	59	53	48	50
Iowa	–	45	–	32
Kansas	39	–	41	–
Kentucky	42	43	43	28
Louisiana	22	28	21	23
Maine	46	42	24	25
Maryland	48	57	27	24
Massachusetts	57	53	15	15
Michigan	56	44	30	22
Minnesota	69	76	65	43
Mississippi	38	41	23	25
Missouri	50	47	42	36
Montana	36	40	28	37
Nebraska	66	65	54	51
Nevada	44	–	21	–
New Mexico	42	40	20	20
New York	64	63	34	31
North Carolina	41	43	46	44
North Dakota	51	51	41	47
Ohio	54	–	37	–
Oklahoma	43	–	39	–
Oregon	34	31	18	21
Rhode Island	68	60	25	34
South Carolina	42	41	29	24
Tennessee	36	33	16	13
Texas	66	62	25	24
Utah	47	41	41	33
Vermont	60	47	20	18
Virginia	56	55	27	27
Washington	–	32	–	29
West Virginia	51	46	53	39
Wisconsin	–	39	–	32
Wyoming	59	63	46	52
NATION	44	47	27	23

NOTES: – Data not available.
* Sample size insufficient to permit reliable estimate.
% with Major = What were your undergraduate major fields of study? (teacher-reported).

SOURCE: The Nation's Report Card, Mathematics 2000 (see for standard errors of estimates).
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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TABLE 30 Science Teachers, Grade 8, with Major in Assigned Field, 2000

STATE	% WITH MAJOR, UNDERGRADUATE DEGREE			
	Science Ed.	Life Science	Physical Science	Earth Science
Alabama	41	43	27	14
American Samoa	23	21	16	15
Arizona	21	38	22	14
Arkansas	44	32	18	25
California	17	47	31	14
Connecticut	25	42	21	15
DDESS	44	37	26	24
DoDDS	48	43	22	17
Georgia	29	19	12	10
Guam	26	36	9	25
Hawaii	23	63	21	17
Idaho	52	46	36	33
Illinois	34	33	20	17
Indiana	47	44	38	18
Kentucky	42	34	19	20
Louisiana	17	16	11	12
Maine	29	41	23	14
Maryland	37	46	18	22
Massachusetts	23	36	15	23
Michigan	50	39	20	18
Minnesota	56	71	25	58
Mississippi	37	34	21	12
Missouri	50	38	17	25
Montana	41	57	35	29
Nebraska	46	43	28	19
Nevada	36	37	29	21
New Mexico	35	35	11	21
New York	31	55	27	24
North Carolina	34	28	11	11
North Dakota	40	39	22	38
Ohio	45	44	29	28
Oklahoma	48	41	25	24
Oregon	38	55	18	30
Rhode Island	41	41	29	21
South Carolina	29	34	15	15
Tennessee	26	31	16	12
Texas	40	58	25	45
Utah	46	55	46	39
Vermont	30	54	23	24
Virginia	32	36	25	12
West Virginia	68	40	29	27
Wyoming	45	62	31	27
NATION	**35**	**39**	**20**	**19**

NOTE: *% with Major* = What were your undergraduate major fields of study? (teacher-reported).

SOURCE: The Nation's Report Card, Science 2000 (see for standard errors of estimates).
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Preparation of Teachers by Student Race/Ethnicity and Poverty Enrollment of School

In reporting indicators of the preparation of teachers in mathematics and science, we need to consider whether variation in teacher preparation is related to the family and community background of students. That is, do certain groups of students get better or less well prepared teachers? It is very important at national, state, and local levels that data on teacher preparation be disaggregated by characteristics of students and schools, to understand how teacher quality is distributed. State-by-state indicators are not currently available, but we can cite several sources for reliable national studies of the differences in teacher preparation.

The summary in Figure 6 of Ingersoll's analysis (1999) of data from the 1994 Schools and Staffing Survey (based on a representative sample of teachers in each field) shows that there are significant differences in preparation of teachers according to the socioeconomic status of students in schools, school size, and experience of teachers. Nationally, 31 percent of all secondary (7-12) teachers of mathematics did not have a college major or minor in the field.[8] In *low-poverty schools*, 27 percent of teachers were assigned out of field, while 43 percent of teachers in *high-poverty* schools did not have a mathematics major or minor.

In science, the disparity is slightly less. Twenty percent of all secondary science teachers did not major or minor in a science field or science education. Among low-poverty schools, 18 percent of teachers were assigned in science who had no major or minor in science, while in high-poverty schools, 28 percent of science teachers were poorly prepared.

FIGURE 6 **Percentage of Math and Science Teachers (Grades 7-12) with a Major or Minor in Assigned Field (SASS, 1994)**

	U.S. Public	Low Poverty	High Poverty
Math (7-12)	69	73	57
Science (All, 7-12)	80	82	72
Life Science	67	71	60
Physical Science	43	49	35

Source: NCES, Schools and Staffing Survey

As a national average, students who are taught in classes with high-minority and high-poverty enrollments have less chance of being taught by a teacher who is well prepared in mathematics or science. Unfortunately, this indicator is not available state by state from SASS due to the limitations on sample size. Many states could not provide this kind of indicator of teacher preparation by student background for the districts or schools in a state. This information might be more useful to local educators than simply the state average for teachers with a major in their field.

[8] Teacher of math = Assigned to teach one or more periods in the subject; Major or minor = Undergraduate or graduate degree with major or minor in mathematics or mathematics education.

Teachers' Professional Development

Professional standards for teaching mathematics (NCTM, 1991) and standards for teaching science (NRC, 1995) recommend that teachers have adequate course-work preparation in the content areas they will be teaching, and in addition the professional organizations recommend ongoing professional development in the subject content and methods of teaching their assigned field and grade level. The NAEP mathematics and science assessment teacher questionnaires ask teachers at grades 4 and 8 to report on their professional development in their teaching field for the previous 12 months. For the 1996 NAEP, data were reported at the state level on professional development of math and science teachers (Blank & Langesen, 1999); however, in 2000 only teachers in the national sample were asked the professional development questions (in an effort to reduce response burden for teachers, per NCES staff). We report trends for 1992 to 2000 at the national level in the chart below.

- ***Math.*** **Data in Figure 7 show an average of 19 percent of teachers in grade 4 received more than 16 hours of professional development in teaching mathematics in 2000, as compared to 28 percent in 1996 and 21 percent in 1992. A total of 52 percent of grade 8 teachers participated in 16 or more hours of math professional development in 2000, and 23 percent had 36 or more hours.**
- ***Science.*** **In 2000, 46 percent of grade 8 science teachers received 16 or more hours of professional development, and 23 percent received 36 or more hours, which represented a decline from the hours of professional development in 1996.**

FIGURE 7 **Hours of Professional Development in Mathematics and Science Education, Nation (Public Schools), 1992 to 2000**

	PERCENTAGE OF TEACHERS				
	Math			Science	
	1992	1996	2000	1996	2000
Grade 4					
16–35 hours PD	10%	15%	12%	9%	7%
36+ hours PD	11	13	7	6	5
Grade 8					
16–35 hours PD	25%	21%	29%	26%	23%
36+ hours PD	22	27	23	31	23

NOTE: Hours = Total time in professional development workshops or seminars in mathematics or math education (science or science education) during the last year.
SOURCE: NCES, National Assessment of Educational Progress (http://nces.ed.gov/nationsreportcard).

These data were collected and reported by state in the 1992 NAEP math assessment and the 1996 NAEP math and science assessments. Unfortunately, NCES dropped these teacher questions from the survey for the 2000 math and science assessments.

Other Sources of Data on Professional Development

Time spent in professional development is only a basic indicator. More information is needed to assess any impact of professional development in improving teaching. The 2000 Schools and Staffing Survey (SASS) included several additional questions about the content areas or

activities of teacher professional development, e.g., in-depth study, teaching methods, education technology. These data from a representative sample of teachers in elementary and secondary schools can be analyzed by subject/field for the nation and for some large states, but not for all states.

The Surveys of Enacted Curriculum in mathematics and science (available from CCSSO; see Blank, et al., 2001; http://www.ccsso.org/sec.html) include a more extensive set of questions that can be asked of teachers, including types of PD activities in the subject/field, time spent, and measures of quality of the activities (e.g., coherence with curriculum, cooperation with other school staff, follow-up activity, content focus, etc.). The Surveys also cover instructional practices and content taught, which allows for evaluation of change in teaching over time in relation to the professional development activities.

Indicators of Demographics of Teaching Force

The state-by-state trends and distributions of science and mathematics teachers across categories of race/ethnicity, gender, and age provide useful indicators for states, professional organizations, and national policymakers to use in analyzing the current supply and demand for teachers. These data are analyzed and reported from state education information systems.

Race/Ethnicity of Science and Mathematics Teachers

- Southeastern states, Texas, California, and Hawaii have the highest proportion of science and math teachers that are from minority populations. In most states, the percentage of minority teachers is one-third of the percentage of minority students.
- The percentages of high school math and science teachers from race/ethnic minority groups have increased gradually in all fields, with slightly larger increases in math. At the same time, minority student enrollments have increased significantly over the decade.

National survey data (Weiss, et al., 2001; NCES/SASS, 1996a) show that minority science and mathematics teachers are vastly under-represented, considering the student population in our schools. Oakes' (1990) analysis of teacher characteristics and student participation and opportunities in science and mathematics demonstrated that the rate of participation of minority and female students in science and mathematics is related to the characteristics of their teachers.

Table 31 ranks the states by the percentage change in minority students from 1990 to 2000. The data show comparisons with the percentage of minority teachers in several fields. No states with more than 20 percent minority enrollment come close to matching the proportions of minority teachers and students. There are no major differences between fields in the percentage of teachers who are minorities, although chemistry has a slightly lower proportion of minority teachers in most states. A complete state-by-state disaggregation of teacher race/ethnicity by five race/ethnic groups—African American, Hispanic, Asian, American Indian, white—for each teaching field is available from the CCSSO website (http://www.ccsso.org/Scimathindicators01.html).

The national trends in four high school fields, below, show small increases since 1990 in the total percentage of teachers who are minority teachers. The increases in minority teachers since 1998 are largely due to the addition of Puerto Rico's teachers to the state S-M database and sharp increases in the number of minority math teachers in Texas.

Minority Teachers in High School Math and Science: 1990 to 2000

	MINORITY TEACHERS			
Field	1990	1994	1998	2000
Mathematics	11%	14%	12%	15%
Biology	10	13	12	14
Chemistry	7	9	8	11
Physics	5	6	6	7

TABLE 31 Minority Teachers in Mathematics and Science by Minority Students in State, 1990 to 2000

STATE	% MINORITY STUDENTS 2000	Change 1990 to '00	% MINORITY TEACHERS Math 2000	Math Change 1990 to '00	Biology 2000	Biology Change 1990 to '00	Chemistry 2000	Chemistry Change 1990 to '00
Nevada	39	+15	7	-2	9	+2	4	+1
California	62	+9	24	+6	20	+4	19	+7
Arizona	45	+9	--	--	--	--	--	--
Virginia	35	+8	--	--	--	--	--	--
Oklahoma	33	+8	6	+1	7	+2	5	+1
Florida	45	+8	22	--	18	--	19	--
Rhode Island	24	+8	5	+3	7	+5	5	0
Maryland	45	+7	--	--	--	--	--	--
Washington	24	+7	--	--	--	--	--	--
Delaware	38	+7	--	--	--	--	--	--
New York	44	+6	--	--	--	--	--	--
Montana	13	+6	--	--	--	--	--	--
Oregon	17	+6	4	--	5	--	--	--
Texas	56	+6	22	+4	23	+6	19	+8
Idaho	13	+6	1	-1	2	+1	1	+1
Alaska	38	+6	--	--	--	--	--	--
Colorado	29	+5	6	+1	6	0	--	--
Minnesota	14	+5	2	--	2	--	2	--
Nebraska	15	+5	1	--	2	--	2	--
NATION	**37**	**+5**	**15**	**+4**	**14**	**+4**	**11**	**+4**
Utah	12	+5	2	0	1	-1	1	0
Massachusetts	23	+5	8	--	8	--	7	--
New Mexico	63	+5	--	--	--	--	--	--
Connecticut	29	+5	5	+2	6	+3	5	+3
Georgia	44	+5	20	--	21	--	--	--
Illinois	39	+5	--	--	--	--	--	--
North Carolina	38	+5	15	+1	16	0	11	0
Kansas	19	+4	3	0	3	+1	3	-3
New Jersey	38	+4	10	0	9	+2	7	+2
Wisconsin	18	+4	3	+1	3	+1	3	+2
Pennsylvania	21	+4	--	--	--	--	--	--
South Dakota	13	+4	0.2	--	1	--	2	--
Tennessee	26	+3	--	--	--	--	--	--
Louisiana	50	+3	--	--	--	--	--	--
Michigan	25	+3	10	+3	4	+1	3	+2
Missouri	20	+3	6	--	5	--	4	--
Iowa	9	+3	1	0	2	+2	2	+1
Ohio	19	+3	4	+1	5	0	4	+2
Wyoming	11	+2	1	--	2	--	2	--
South Carolina	44	+2	--	--	--	--	--	--
Arkansas	27	+2	10	0	10	0	5	-1
Hawaii	79	+2	--	--	--	--	--	--
North Dakota	10	+2	0	0	1	0	2	+1
Kentucky	12	+2	2	0	4	+1	2	+1
Alabama	39	+2	17	-1	17	-2	16	-1
Mississippi	52	+1	22	-4	24	-6	27	0
Indiana	15	+1	4	+1	3	0	3	+1
Maine	3	+1	1	+1	0.3	0	0.5	0
Vermont	3	+1	2	--	0	--	0	--
New Hampshire	4	+1	--	--	--	--	--	--
West Virginia	5	0	2	--	2	--	2	--
Dist. of Columbia	96	0	--	--	--	--	--	--
Virgin Islands	99	-1	--	--	--	--	--	--
Puerto Rico	100	--	100	--	100	--	100	--
DoDEA	--	--	--	--	--	--	--	--

NOTES: -- Data not available.
Colorado: Biology = all science; New Jersey: grades 7-12; Vermont: data includes imputation.
Grades 9-12 teachers assigned one or more period to subject.
Percent minority teachers = Asian/Pacific Islander, African-American, Hispanic, and American Indian teachers.

SOURCE: (Téachers 9-12) State Departments of Education, 1999-00; (Students K-12) NCES, Common Core of Data, Fall 1998.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Gender of Science and Mathematics Teachers

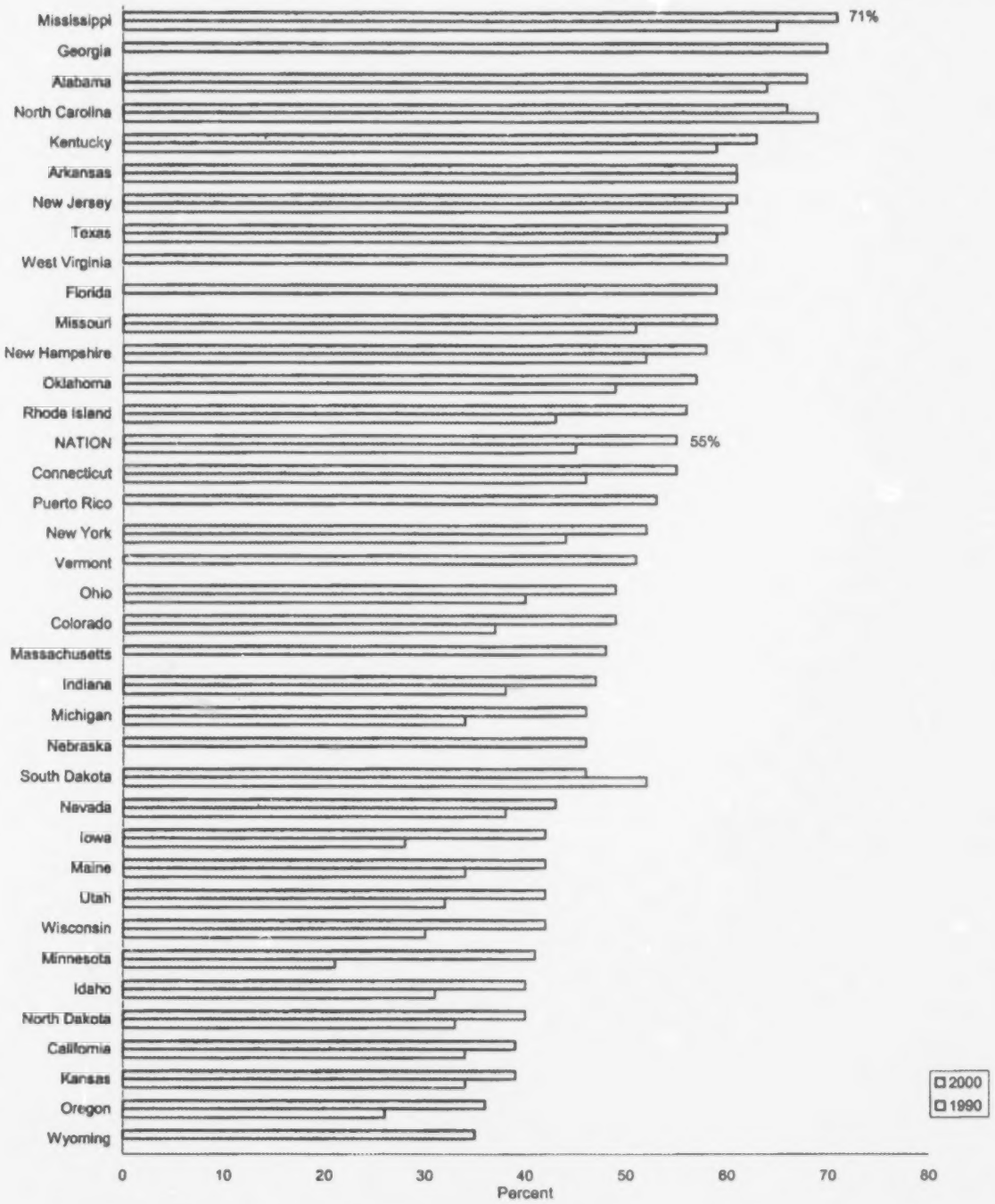
- Data in Figure 8 show that the numbers of female teachers have increased significantly in high school mathematics from 1990 to 2000 across the states. The table below shows the national trends for four subjects. As of 2000, more than half of mathematics teachers in grades 9-12 are women, half of biology teachers are women, and almost half of chemistry teachers are women.

Female Teachers in High School Math and Science: National Percentages—1990 to 2000

Field	1990	1994	1998	2000
Mathematics	45%	50%	56%	55%
Biology	37	45	50	50
Chemistry	34	40	44	46
Physics	22	25	29	29

The gender distribution of all mathematics and science fields shows that geographic region is associated with the proportion of teachers that are female (see website Appendix for percentages by field and state). The state map of chemistry teachers by gender in Figure 9 shows the regional pattern. Four states that reported over 55 percent female chemistry teachers are all in the Southeast. The percentage of females among chemistry teachers is lower in the Midwest states.

FIGURE 8 Gender of Mathematics Teachers (Percent Female), 1990 to 2000



NOTE: Grades 9-12 teachers assigned one or more period to subject.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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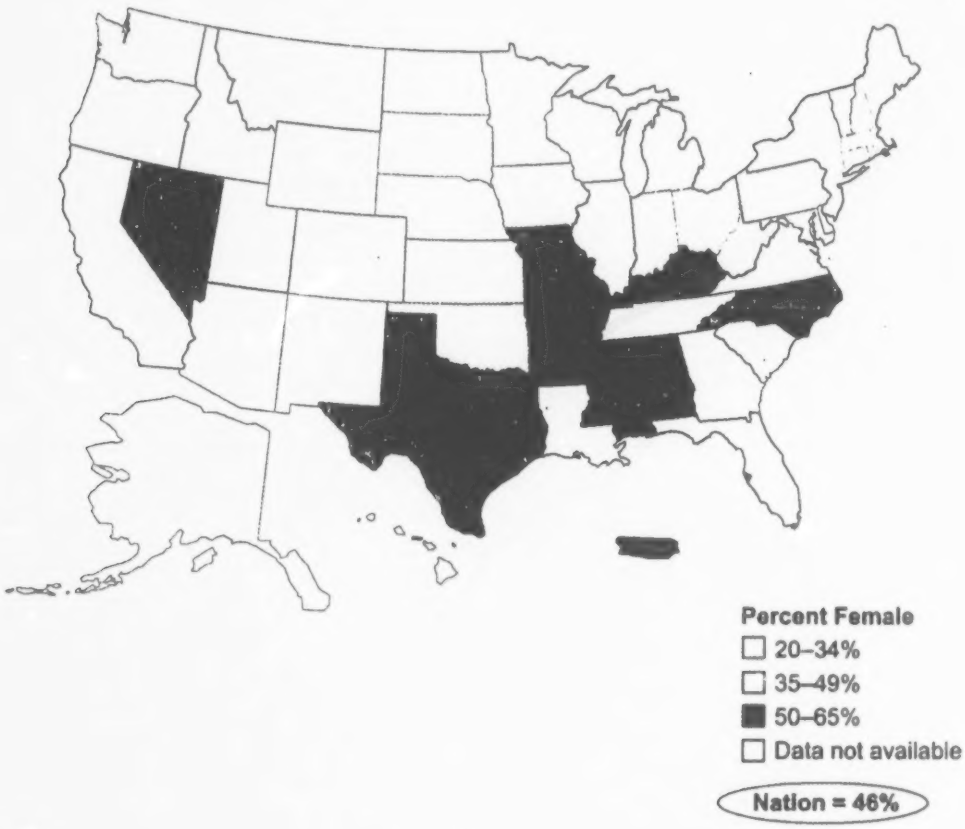
FIGURE 9 **Gender of Chemistry Teachers, Percent Female by State, 2000**



NOTES: DoDEA, Virgin Islands, Washington, D.C. = n/a; New Jersey: grades 7-12; Vermont: data includes imputation. Grades 9-12 teachers assigned one or more period to chemistry.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

Age Distribution of Science and Mathematics Teachers

› **In 2000, 27 percent of grades 9-12 math teachers are over age 50, up 8 percentage points since 1990, and the percentage of teachers of physics over 50 has gone up 9 points. At the same time, the percentage of young teachers, under age 30, has gone up only 2 percentage points.**

In 1989–90, states began reporting data to CCSSO on the age distribution of science and mathematics teachers. With 1999–2000 data, we have ten-year trends in teacher age by field by state.

Teachers over Age 50 in High School Math and Science: 1990 to 2000

Field	1990	1994	1998	2000
Mathematics	19 %	23%	24%	27%
Biology	20	24	25	28
Chemistry	22	26	28	30
Physics	23	27	28	32

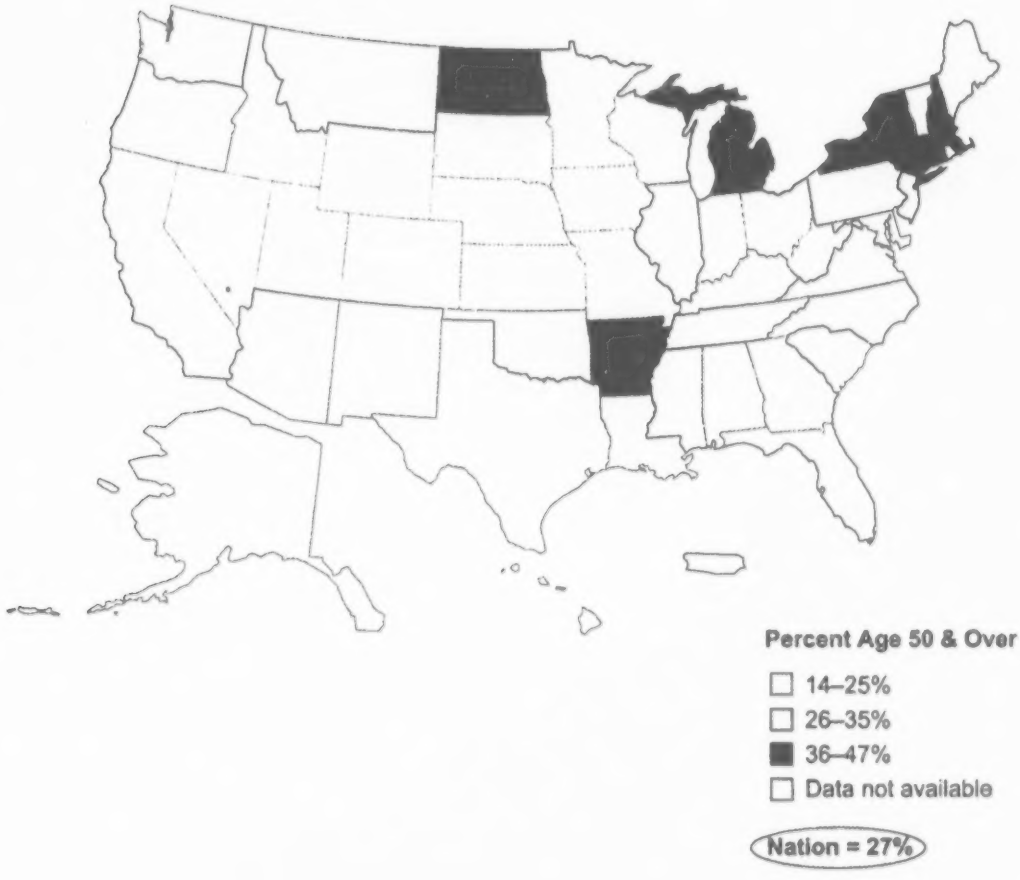
The map in Figure 10 shows the percentage of high school m*athematics* teachers over age 50 by state. It reveals that states in the Northeast and Midwest have an aging teaching force. Seven states have 36 percent or more of their teachers over age 50 – Arkansas, Connecticut, Massachusetts, Michigan, New Hampshire, New York, and North Dakota. The data in Table 32 indicate the percentage of teachers over 50 has gone up over 10 points since 1990 in 15 states with the highest rates of increase in Arkansas, Connecticut, Michigan, North Dakota, and Ohio.

In Table 33, the data show that 12 states have over one-third of their *physics* teachers over age 50 including Indiana, Utah, North Dakota, Minnesota, New Hampshire, New York, Connecticut, Massachusetts, and Maine. The percentage of physics teachers over age 50 has gone up over 10 points since 1990 in most states, with the highest increases in North and South Dakota, Michigan, and Ohio. These states are facing shortages of physics teachers due to impending retirements of many of their teachers.

› **As you study** data on demographics of math and science teachers, consider the following questions:

- What are the key issues concerning teacher recruitment, and hiring in your state—i.e., attracting more minority teachers, increasing the balance of female and male teachers, or how to offset the loss of a large group of teachers in the next five years?
- What other variables other than those reported here are critical for providing an adequate, well-prepared science and math teaching force in your state?
- How have increased requirements for licensure, including teacher assessment, affected the hiring of more minority teachers in your state?
- What is being done to educate and hire more qualified math and science teachers in your state?

FIGURE 10 **Mathematics Teachers Age 50 and Over, by State, 2000**



NOTES: DoDEA, Virgin Islands, Washington, D.C. = n/a; New Jersey: grades 7-12; Vermont: data includes imputation. Grades 9-12 teachers assigned one or more period to mathematics.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

TABLE 32 Age of Mathematics Teachers, 1990 to 2000

STATE	% Under Age 30		% Age 50 & Over	
	% 2000	Change 1990 to '00	% 2000	Change 1990 to '00
Kentucky	26	+7	18	+8
North Carolina	25	+5	26	+16
New Jersey	24	+14	14	-5
Alabama	23	+10	20	+7
Georgia	23	--	22	--
Kansas	21	-1	29	+8
Mississippi	20	+6	25	+8
Missouri	19	0	31	+16
Indiana	19	+4	31	+14
Nebraska	19	--	32	--
Wisconsin	18	+5	31	+10
Iowa	18	+3	32	+14
Minnesota	18	+8	32	+3
Colorado	18	+9	26	+4
Ohio	18	+2	33	+20
South Dakota	17	-1	34	+12
Nevada	16	+5	27	+5
Utah	16	0	28	+6
California	16	+3	35	+9
New York	15	+6	37	+17
NATION	**15**	**+2**	**27**	**+8**
Vermont	15	--	31	--
Florida	15	--	31	--
Oklahoma	15	-2	22	+11
Idaho	14	-3	31	+12
New Hampshire	14	--	43	--
Massachusetts	14	--	40	--
Arkansas	14	0	36	+21
Maine	13	-1	33	+18
Oregon	13	+1	25	+3
Connecticut	12	+6	44	+24
Rhode Island	11	+8	34	+19
Wyoming	10	--	35	--
North Dakota	9	-13	36	+23
Michigan	9	+1	47	+23
West Virginia	8	--	31	--
Puerto Rico	5	--	20	--

NOTES: -- Data not available. New Jersey: grades 7-12; Vermont: data includes imputation. Grades 9-12 teachers assigned one or more period to subject.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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TABLE 33 Age of Physics Teachers, 1990 to 2000

STATE	% Under Age 30		% Age 50 & Over	
	% 2000	Change 1990 to '00	% 2000	Change 1990 to '00
Kentucky	24	+8	21	+9
Alabama	22	+6	20	+2
New Jersey	21	+14	21	-7
Kansas	21	+7	30	+7
North Carolina	17	+2	33	+16
Mississippi	17	+8	34	+14
Massachusetts	16	--	43	--
Arkansas	16	+3	26	+4
Minnesota	15	+7	31	-2
Nevada	15	+8	26	+6
Indiana	14	+1	36	+11
Utah	14	+4	33	+14
Iowa	14	-2	35	+14
Wisconsin	14	+5	31	+1
Florida	14	--	34	--
NATION	**13**	**+2**	**32**	**+9**
Nebraska	13	--	33	--
South Dakota	13	-9	38	+20
Missouri	13	-1	31	+10
California	12	-2	32	+10
Idaho	12	-1	33	+2
North Dakota	12	-2	44	+28
New York	11	+4	38	+11
Oklahoma	11	+4	30	+12
Wyoming	11	--	39	--
Ohio	10	-3	42	+28
Michigan	9	+3	48	+19
West Virginia	9	--	32	--
New Hampshire	8	--	49	--
Maine	8	-5	36	+15
Rhode Island	6	+4	35	+17
Connecticut	5	-2	44	+15
Vermont	5	--	40	--
Puerto Rico	3	--	22	--

NOTES: -- Data not available. New Jersey: grades 7-12; Vermont: data includes imputation. Grades 9-12 teachers assigned one or more period to subject.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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New Teachers in High School Math and Science

- **Of the 30 states reporting number of new teachers for 2000 in Table 34, four states had more than 10 percent of their high school mathematics teaching force that are new, inexperienced teachers. Two states had more than 10 percent new, inexperienced science teachers in high schools.**
- **Nationally, 7 percent of math and science high school teachers were new for the 1999–00 school year and had no teaching experience. In 1996 the percent of new math teachers was the same as 2000 (7 percent), while the number of new science teachers has increased from 5 percent in 1996.**

An important indicator of teacher supply in science and mathematics is the number of new teachers entering the teaching profession, particularly in relation to the demand for teachers. The data on age of the current teaching force, described above, show that almost half the states will have one-third or more of their high school science and math teachers retiring in the next few years, and many states have few younger teachers under age 30. With the current increases in student enrollments experienced by most states, it is certain that additional new teachers will be needed in science and mathematics.

For the 1999–2000 school year, 30 states were able to report data on the number of new teachers in science and mathematics. Table 34 highlights the proportion of high school science and mathematics teachers that are new, first-year teachers with no experience teaching. This is a key indicator that most states and districts will want to track closely.

Several of the states with higher rates of new teachers (over 10 percent) were among the states with sharply increased size of the teaching force in the 1990s, as reported in Table 23, including Kansas, North Carolina, California, Texas, and Vermont. In 2000, Texas and California had over 1,000 new math teachers, and North Carolina had over 500 new teachers, while in science, New York and Texas had over 500 new science teachers.

TABLE 34 New Teachers in High School Science and Mathematics, 1996 to 2000

	NEW FIRST-YEAR TEACHERS					
	MATH			SCIENCE		
STATE	Total, 2000	% New	% Change 1996 to 2000	Total, 2000	% New	% Change 1996 to 2000
Alabama	119	6	-3	88	5	0
Alaska	--	--	--	--	--	--
Arizona	--	--	--	--	--	--
Arkansas	80	6	-2	112	16	+10
California	1,032	10	+4	416	6	+2
Colorado	--	--	--	--	--	--
Connecticut	73	4	+2	45	2	0
Delaware	--	--	--	--	--	--
Dist. of Columbia	--	--	--	--	--	--
DoDEA	--	--	--	--	--	--
Florida	--	--	--	--	--	--
Georgia	203	7	--	76	6	--
Hawaii	--	--	--	--	--	--
Idaho	105	12	-3	122	17	+5
Illinois	--	--	--	--	--	--
Indiana	101	4	0	97	4	+1
Iowa	77	6	+2	65	4	+1
Kansas	170	11	--	132	9	--
Kentucky	119	7	0	62	4	0
Louisiana	--	--	--	--	--	--
Maine	23	3	0	27	3	+2
Maryland	--	--	--	--	--	--
Massachusetts	191	6	+2	93	3	0
Michigan	88	4	--	30	3	--
Minnesota	99	5	+1	97	5	+1
Mississippi	96	8	-6	84	6	0
Missouri	--	--	--	--	--	--
Montana	--	--	--	--	--	--
Nebraska	--	--	--	--	--	--
Nevada	46	8	--	38	7	--
New Hampshire	--	--	--	--	--	--
New Jersey	--	--	--	--	--	--
New Mexico	--	--	--	--	--	--
New York	371	4	+2	559	5	+3
North Carolina	535	13	-1	268	8	-2
North Dakota	10	2	+1	13	2	-1
Ohio	254	7	+3	171	5	+2
Oklahoma	115	6	0	82	4	0
Oregon	46	4	+1	13	4	+1
Pennsylvania	--	--	--	--	--	--
Puerto Rico	120	4	0	15	1	-2
Rhode Island	--	--	--	--	--	--
South Carolina	--	--	--	--	--	--
South Dakota	26	5	-13	26	4	-1
Tennessee	--	--	--	--	--	--
Texas	1,896	8	0	738	7	0
Utah	44	6	-8	32	4	-9
Vermont	45	12	--	30	7	--
Virgin Islands	--	--	--	--	--	--
Virginia	--	--	--	--	--	--
Washington	--	--	--	--	--	--
West Virginia	26	2	--	12	2	--
Wisconsin	108	4	+1	65	3	0
Wyoming	6	2	--	12	5	--
NATION		7	0		7	+2

NOTES: -- Data not available.
New = No experience; Vermont: data includes imputation.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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- **In high school mathematics, seven states have student/teacher ratios averaging over 120 to 1, while 15 states have ratios that average less than 100 to 1.**
- **In chemistry teaching, three states have student/teacher ratios that average over 120 to 1, and 16 states have ratios of less than 100 to 1.**

This indicator provides a basic estimate of how many students the average high school teacher in a state must work with during a given school day or week. For states, these ratios also provide an estimate of the current supply of teachers in relation to the enrollment demand from students.

A high ratio (e.g., California, 124 students per math teacher) means that teachers have to work with more students on a daily basis than teachers in a state with a lower ratio (e.g., Alabama, 73 students per math teacher). Several states have high students per teacher in each science field, including Kentucky, Louisiana, and Utah, while several have low ratios—Alabama, Massachusetts, Oklahoma, Vermont, and Wyoming. In chemistry, the student/teacher ratios vary from a high of 191 students per FTE teacher in Louisiana to a low of 54 students per teacher in Vermont.

TABLE 35 Students per Teacher in Mathematics and Science, Grades 9-12

STATE	STUDENTS/FTE TEACHER Mathematics	Biology	Chemistry	Physics
Alabama	73	78	74	70
California	124	121	117	106
Connecticut	92	85	81	76
Idaho	98	112	101	77
Indiana	102	99	90	80
Kentucky	130	122	122	111
Louisiana	148	164	191	201
Massachusetts	88	77	70	72
Minnesota	90	99	97	84
Mississippi	121	115	91	68
Missouri	93	101	97	74
Nebraska	86	96	91	69
Nevada	129	117	106	81
New York	100	66	80	72
North Carolina	119	116	110	86
North Dakota	92	100	88	61
Ohio	139	129	106	93
Oklahoma	73	74	71	52
Puerto Rico	61	63	68	43
South Dakota	80	93	93	61
Texas	77	92	86	74
Utah	227	235	172	139
Vermont	74	62	54	44
West Virginia	93	76	–	–
Wisconsin	109	101	114	109
Wyoming	89	76	79	84

NOTES: – Data not available. Vermont: data includes imputation; West Virginia: Biology=Integrated Science. Students per teacher ratio based on number of students enrolled in subject divided by estimated number of FTE teachers assigned to subject.

SOURCE: State Departments of Education, Data on Public Schools, 1999-00.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Instructional Resources for Science and Mathematics

- ***Availability of Computers.*** **At least one computer was available in 72 percent of grade 4 students' classrooms in 2000, and in 46 percent of grade 8 math students' classrooms.** In grade 8 science, 50 percent of students have one or more computers in the classroom and 92 percent of students have them available in a computer lab.
- ***Use of Computers in Instruction.*** **As of 2000, 75 percent of grade 8 science classes use computers in instruction, which is a significant increase from 1996 when 54 percent of grade 8 science teachers reported some use of computers.** The primary uses in science instruction are for Data analysis (34 percent) and Internet (24 percent).
- ***Teacher Views of Materials and Resources.*** **Among teachers at grade 4, 69 percent reported in 2000 that they receive all or most of the materials and resources they need to teach the class, which compared to 63 percent in 1992.** State percentages on these statistics vary from 47 percent positive responses in the District of Columbia to 89 percent in Montana.

Availability and Use of Computers. The NAEP teacher questionnaire in mathematics and science asked teachers to report on the availability of computers for instruction and their primary uses in the classroom. The results by state are reported in Tables 36–38.

Nationally, about three-quarters of classes at grade 4 have at least one computer available in the classroom, but fewer classrooms have computers in grade 8. In grade 4 mathematics, one-fourth of teachers reported that computers are not used in instruction. Over 40 percent of teachers reported the primary use of computers in instruction was for students to play mathematical games, and 24 percent of classes use computers primarily for drill and practice in mathematics. States varied widely in computer availability in classrooms, from 92 percent in Rhode Island to 49 percent of students in Arkansas.

For grade 8 use of computers in mathematics instruction (Table 37), only half of the classes have computers in the classroom (with most teachers reporting they are available in computer labs). Teachers of 51 percent of students report no use of computers in instruction. Among the teachers reporting some use in instruction, 16 percent of grade 8 classes primarily use computers for drill and practice, and 12 percent use them for simulations and applications. State availability rates in grade 8 classrooms varied from 83 percent in the District of Columbia to 19 percent in Minnesota.

The data in Table 38 show that only 50 percent of grade 8 science classes had computers available in the classroom. Teachers of 25 percent of science students report no use of computers in instruction. The primary uses for science instruction were for data analysis (34 percent), use of Internet (24 percent), and simulations and modeling (22 percent). Across the states, Hawaii had 68 percent of science classes with computers available as compared to only 31 percent in Rhode Island.

TABLE 36 Availability and Use of Computers in MATHEMATICS Instruction, Grade 4, 2000 NAEP

STATE	COMPUTER AVAILABILITY: In Class (One or More) % students	PRIMARY USE IN INSTRUCTION % students: Drill and Practice	Playing Math Games	Simulations/ Apps	Do Not Use Computers
Rhode Island	92	11	62	6	20
Idaho	91	33	45	2	20
Ohio	91	27	41	11	21
Tennessee	88	29	47	4	19
Kentucky	87	36	41	4	18
Hawaii	85	15	30	5	50
Nevada	82	21	44	5	28
North Carolina	82	34	42	8	14
Vermont	82	12	44	4	40
Connecticut	81	34	37	5	23
Massachusetts	81	19	39	5	35
South Carolina	80	31	33	6	29
Georgia	79	37	39	6	18
New York	79	20	38	7	34
North Dakota	79	23	49	2	25
Virginia	78	29	42	10	17
Louisiana	77	29	40	10	20
New Mexico	77	24	42	8	25
DDESS	76	39	41	8	10
Montana	76	36	33	8	22
Oregon	76	18	36	5	41
California	75	22	42	2	31
District of Columbia	75	23	35	5	34
Maine	75	23	39	3	33
Alabama	73	45	23	3	28
Kansas	72	31	33	6	29
NATION	**72**	**24**	**42**	**6**	**25**
Nebraska	72	36	36	1	24
Indiana	71	40	39	6	13
Illinois	70	31	37	6	24
Mississippi	69	38	29	6	26
Arizona	67	27	33	6	32
Iowa	67	31	37	4	27
Missouri	67	26	42	6	24
West Virginia	67	71	17	5	2
Texas	66	26	44	12	16
Michigan	63	20	43	6	30
Oklahoma	60	36	34	3	24
DoDDS	59	27	33	8	29
Wisconsin	56	32	35	7	26
Minnesota	53	22	28	8	39
Utah	53	26	36	3	33
Maryland	51	27	28	10	33
Wyoming	51	41	28	8	20
Arkansas	49	46	17	11	24
Virgin Islands	17	12	11	4	74
Guam	12	35	18	3	41
American Samoa	6	9	30	5	55

NOTES: American Samoa: 4 or more computers in class: Guam, Virgin Islands: 1-3 computers in class.
Availability = Which best describes the availability of computers for use by students in your mathematics classes? (teacher-reported).
Primary Use = If you do use computers, what is the primary use of these computers for mathematics instruction? (teacher-reported). Other use = demonstrate new topics.

SOURCE: The Nation's Report Card, Mathematics 2000 (see for standard errors of estimates).
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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TABLE 37 Availability and Use of Computers in MATHEMATICS Instruction, Grade 8, 2000 NAEP

STATE	COMPUTER AVAILABILITY: In Class (One or More) % students	PRIMARY USE IN INSTRUCTION % students: Drill and Practice	Playing Math Games	Simulations/ Apps	Do Not Use Computers
District of Columbia	83	27	21	19	18
Kentucky	65	13	13	22	46
Tennessee	63	20	22	8	44
South Carolina	59	33	12	12	38
Hawaii	59	11	15	9	62
Mississippi	58	16	12	3	61
DDESS	58	27	13	27	23
Georgia	58	29	11	14	41
Alabama	57	28	13	7	43
Nevada	57	8	13	17	53
Idaho	55	17	10	13	56
Maine	54	7	3	20	64
Vermont	54	6	9	31	47
New Mexico	52	13	19	11	52
Illinois	50	8	21	14	52
North Carolina	50	27	11	14	42
Oregon	48	7	10	18	56
Kansas	47	12	7	8	68
Louisiana	47	29	18	7	40
Texas	47	25	14	13	39
NATION	**46**	**16**	**13**	**12**	**51**
New York	46	10	7	19	54
West Virginia	46	35	16	15	29
California	45	12	10	10	60
Massachusetts	45	8	9	16	56
Virginia	44	18	9	23	39
Ohio	43	18	11	21	40
Arkansas	42	21	9	5	62
Arizona	41	10	5	13	65
Missouri	41	13	9	18	51
Oklahoma	41	15	16	4	61
Wyoming	39	11	22	18	40
Nebraska	37	11	14	17	44
North Dakota	37	6	7	24	42
Montana	36	8	12	24	42
Maryland	34	21	9	22	37
Wisconsin	31	6	8	26	51
DoDDS	31	3	3	45	37
Michigan	30	6	10	16	58
Utah	28	10	6	10	64
Connecticut	27	6	9	28	51
Rhode Island	25	5	12	21	57
Indiana	23	22	14	14	38
Minnesota	19	9	9	36	37
Guam	0	1	–	0	99
American Samoa	–	–	23	7	38

NOTES: – Sample size insufficient to permit reliable estimate. Guam: 1 computer in class.
Availability = Which best describes the availability of computers for use by students in your mathematics classes? (teacher-reported).
Primary Use = If you do use computers, what is the primary use of these computers for mathematics instruction? (teacher-reported). Other use = demonstrate new topics.

SOURCE: The Nation's Report Card, Mathematics 2000 (see for standard errors of estimates).
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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TABLE 38 Availability and Use of Computers in SCIENCE Instruction, Grade 8, 2000 NAEP

STATE	COMPUTER AVAILABILITY % students		PRIMARY USE IN INSTRUCTION % students			
	In Class (One or More)	In Computer Lab	Simulations and Modeling	Data Analysis/ Other Applications	Use Internet	Do Not Use Computers
Hawaii	68	95	17	28	19	16
Nevada	65	87	26	33	20	19
Ohio	63	94	30	39	21	24
Kentucky	61	93	29	48	22	12
Georgia	61	85	30	37	25	20
Alabama	60	86	18	25	18	29
South Carolina	60	89	30	40	25	17
DoDDS	60	100	28	60	28	12
Idaho	59	93	38	44	20	13
Tennessee	57	74	30	30	21	28
Louisiana	55	85	32	26	19	28
Mississippi	54	83	15	33	21	32
Maine	53	92	28	38	29	18
Wyoming	53	98	42	51	24	13
Vermont	52	94	17	49	21	11
California	51	88	26	36	26	22
Texas	51	95	29	43	22	17
Virginia	51	97	25	49	20	18
West Virginia	51	98	32	41	22	14
NATION	**50**	**92**	**22**	**34**	**24**	**25**
New York	50	96	16	30	21	25
Oklahoma	49	83	19	23	17	32
Arizona	47	90	31	33	23	29
DDESS	47	100	34	39	27	7
Oregon	47	93	20	40	22	21
Montana	46	97	24	44	18	20
New Mexico	46	92	23	29	22	28
North Carolina	46	95	16	36	20	27
Illinois	46	98	25	40	22	17
Missouri	43	93	25	39	21	20
Nebraska	43	98	40	53	24	7
North Dakota	42	99	35	50	24	12
Massachusetts	42	96	20	32	22	23
Connecticut	41	97	27	44	24	18
Michigan	41	89	29	33	19	24
Arkansas	40	88	14	22	19	43
Minnesota	39	100	32	46	21	14
Utah	35	98	23	31	16	23
Indiana	34	94	34	36	19	15
Maryland	33	96	28	40	20	25
Rhode Island	31	94	23	39	29	18
Guam	11	42	18	34	28	58
American Samoa	3	81	--	10	39	45

NOTES: -- Sample size insufficient to permit reliable estimate. American Samoa: 1 computer in class; Guam: 4 or more computers in class. *Availability* = Which best describes the availability of computers for use by your science students? (teacher-reported); Are computers available to students in your classes in any of the following ways? Grouped in a separate computer laboratory available to classes (school-reported). *Primary Use* = How do you use computers for instruction in science? Simulations and modeling, Data analysis and other applications, Do not use computers for science instruction (teacher-reported); If you are taking a science class this year, about how often do you use a computer to do the following? Use the Internet to exchange information with other students or scientists about science experiments or investigations (student-reported).

SOURCE: The Nation's Report Card: Science 2000 (see for standard errors of estimates).
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Teacher Views of Materials and Resources. Data in Table 39 show that in 1992, more than one-third of grade 4 teachers nationally (38 percent) reported they received only "some or none of the materials and resources" they need to teach the class. By 2000, teacher views of the materials/resources improved, with the level reporting only "some or none" down to 31 percent. In several states, teachers' perceptions about the materials and resources improved considerably in eight years. Notable improvements in the positive perceptions of teachers are in Louisiana (47 percent to 70 percent), Arizona (53 percent to 70 percent), North Carolina (48 percent to 74 percent) and Alabama (47 percent to 76 percent).

This is one of the few indicators we report on science-math education based on perceptions or attitudes of staff. We include this measure because research has demonstrated it has predictive validity, i.e., it has a consistent relationship to outcomes. Analyses of NAEP results by states since 1990 across several subjects (Grissmer, et al., 2000) showed that this variable was significantly related to average state achievement scores and improvement of state scores in math.

TABLE 39 Teacher Views of Resources and Materials Provided for Math Instruction, Grade 4, 1992 to 2000 NAEP

	Get ALL OR MOST Materials/Resources % students		Get SOME OR NONE Materials/Resources % students	
STATE	**2000**	**1992**	**2000**	**1992**
Montana	89	–	12	–
Kentucky	86	65	14	36
Wyoming	85	82	15	18
Arkansas	84	57	16	43
Texas	84	68	16	32
DDESS	83	–	17	–
DoDDS	83	–	17	–
Michigan	82	52	18	48
Nebraska	81	82	19	17
Idaho	81	64	18	36
Kansas	81	–	19	–
Vermont	81	–	18	–
Iowa	80	77	20	23
South Carolina	80	63	20	37
Indiana	79	64	20	36
North Dakota	79	58	20	42
Virginia	79	65	20	35
West Virginia	79	62	21	38
Mississippi	79	48	21	52
New York	78	60	22	39
Alabama	76	47	24	53
Minnesota	76	68	24	31
Ohio	76	51	24	50
Georgia	74	64	27	36
Maryland	74	53	26	46
Missouri	74	67	25	33
North Carolina	74	48	27	52
Connecticut	73	69	28	30
Illinois	72	–	28	–
Arizona	70	53	30	48
Louisiana	70	47	29	53
NATION	69	63	31	38
Nevada	68	–	32	–
Tennessee	68	50	32	51
Massachusetts	66	53	35	47
Oklahoma	66	61	34	39
Maine	65	59	35	40
Oregon	62	–	37	–
California	61	54	39	46
Rhode Island	58	43	42	57
New Mexico	56	52	44	49
Utah	53	47	46	53
Hawaii	51	48	49	53
District of Columbia	47	23	53	77
American Samoa	30	–	70	–
Guam	14	36	87	64
Virgin Islands	4	–	96	–
Colorado	–	66	–	34
Delaware	–	49	–	51
Florida	–	66	–	33
New Hampshire	–	52	–	47
New Jersey	–	62	–	38
Pennsylvania	–	66	–	34
Wisconsin	–	70	–	30

NOTES: – Data not available.
Virgin Islands: 4% = most resources only.
Question: Teacher gets resources/materials = Which of the following statements is true about how well your school system provides you with the instructional materials and other resources you need to teach your class? (teacher-reported).

SOURCE: The Nation's Report Card, Mathematics 2000 (see for standard errors of estimates).
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Appendix A
Data Sources and Computations

Data Sources

National Assessment of Educational Progress (NAEP)

The National Assessment of Educational Progress (NAEP) is a congressionally mandated project of the National Center for Education Statistics (NCES) that has collected and reported information for over 25 years on what U.S. students know and what they can do. It is the nation's only ongoing, comparable, and representative assessment of student achievement. Its assessments are given to scientific samples of youths attending both public and private schools and enrolled in grades 4, 8, or 12. The assessment questions are written around a framework prepared for each content area (reading, writing, math, science, and others) that represents the consensus of groups of curriculum experts, educators, members of the general public, and user groups on what should be covered on such a test. Reporting includes means and distributions of scores, as well as more descriptive information about the meaning of different points on the NAEP scale.

NAEP's 2000 mathematics assessment included nearly 259,000 4^{th}-, 8^{th}-, and 12^{th}-grade students attending approximately 10,000 schools across the nation and the states, and the 2000 science assessment included 240,000 students in the same grades. The assessment itself was forward looking, comprising several hundred questions at each of the grades assessed. Consistent with the standards of the National Council of Teachers of Mathematics (NCTM) and the National Research Council (science), many of the questions required students to construct their responses; and some questions asked for explanations of their reasoning. For various portions of the assessment, mathematical and scientific tools and laboratory materials were supplied, including scientific calculators, protractor/rulers, and geometric shapes.

Nationally representative samples of students attending both public and private schools were assessed at grades 4, 8, and 12. Samples of fourth and eighth graders attending public schools were assessed in 41 states and six jurisdictions in math and science.

Advanced Placement Examination (AP)

The Advanced Placement (AP) Program, a cooperative educational endeavor, is based on the premise that college-level material can be taught successfully to able and well-prepared secondary school students. Participating colleges, in turn, grant credit or appropriate placement to students who have done well on the AP Examinations. Approximately 60 percent of the nation's 22,000 high schools offer some college-level AP coursework, and more than 750,000 students participate in the AP Program each year. Use by both schools and students has grown steadily in recent years.

In response to increased interest in the AP Program, the College Board produces, as part of its reporting process, a series of tables reflecting student participation in the 2000 AP Examinations. A more detailed understanding of AP trends and related information can be found in the companion publication, the 2000 AP Yearbook.

The College Board annually publishes summary reports for the nation and for each of the 50 states. The reports give tables with the number of students taking examinations and the number receiving each grade: 1 = no recommendation, 2 = possibly qualified, 3 = qualified, 4 = well qualified, 5 = extremely well qualified.

State Data

State departments of education report aggregated totals on course enrollments and teacher characteristics in science and mathematics to CCSSO. Data are collected by states through state management information systems. For 1999-2000, three states aggregated their data from student records, four states aggregated data from a teacher form, and the remaining states aggregated data from schools; the data are often reported through school districts. The state totals for public schools are aggregated and reported to the Council using common data definitions and reporting forms (CCSSO, 1999). The data refer to the status of students and teachers on or about October 1. Each state's data codes for course enrollments and teacher assignments are cross-walked by CCSSO staff using the course taxonomy and common data category definitions developed by CCSSO with the states (see Appendix B).

For the science and mathematics indicators from the 1999–00 school year, 39 states, DoDEA, the District of Columbia, and Puerto Rico reported some state-collected data. Data on science and mathematics teachers were reported by 39 states, and course enrollments were reported by 33 states.

Computation of Estimated Proportion of High School Students Taking Selected Mathematics and Science Courses by Graduation

The percentages shown in Tables 7 and 10 for each course are statistical estimates of course-taking of high school students by the time they graduate, based on the total course enrollment in grades 9-12 as of fall 1999 divided by the estimated number of students in a grade cohort during four years of high school.

Synthetic cohort statistics have been used previously in education. For example, a synthetic high school dropout statistic has been estimated, based on the sum of the percentages of students who drop out at each grade, for grades 9-12 (Kominski, 1993). Cross-sectional data on dropouts by grade are used to estimate a true dropout rate over a four-year period of high school. A true dropout rate requires tracking the status of the same group of students (cohort) through four years of high school. If only cross-sectional data are available, the synthetic cohort statistic provides an estimate of the high school dropout rate.

The Science and Mathematics Indicators Project desired a synthetic cohort statistic of the proportion of graduates in a state that take a given course, e.g., Biology 1. Since most states do not collect data by grade, the approach used in computing a synthetic dropout statistic had to be revised. First, the numerator is the total number of students in grades 9-12 that took a given course, e.g., Biology, first year, in fall 1999. The denominator is an estimate of the number of students in a cohort of students summed over a four-year period of high school. For each state, the size of the cohort of students that have some probability of taking a given course, e.g., Biology 1, during four years of high school is estimated by: the state student membership in each grade (for grades 9-12) weighted by the regional percentage of students that took the course at each grade level, and summing the weighted memberships for each grade for grades 9-12. The state student memberships by grade are from the 1998-99 Common Core of Data (NCES), and the regional percentages were obtained from the 1998 National Transcript Study (Roey, et al., 2001).

The computation of the science/mathematics course-taking synthetic cohort statistic can be summarized as follows, using the example of Biology 1:

Estimated proportion of students taking Biology 1 in state A	=	Biology 1 enrollment (9-12) *(Reported by state A)* Estimated number of students in cohort in grades 9-12 *(from CCD and regional weights based on NAEP transcript study)*
Estimated students in cohort	=	(M9xBio 1/9)+(M10xBio 1/10)+(M11xBio 1/11)+(M12xBio 1/12) Where M9 is the student membership for grade 9 *(from NCES Common Core of Data)*
(Four regions designated by Westat—Northeast, North Central, South Central, and West).		Bio 1/9 is the percentage of 1998 graduates in state A's region that took Biology 1 in grade 9 *(from Westat, Inc. transcript data files).*

The estimated percentages of students taking a course by graduation, based on state data, can be compared with rates based on student transcripts from studies conducted by the National Center for Education Statistics. For example, national estimates of course-taking from 1997–98 aggregated state data (Blank & Langesen, 1999) were: Biology 92 percent, Chemistry 54 percent, Physics 24 percent; while figures from the National Transcript study (1998) were: Biology 93 percent, Chemistry 61 percent, Physics 29 percent. In mathematics, state aggregate data reported: Geometry 72 percent, Algebra 2 63 percent, Trigonometry/Pre-calculus 39 percent, Calculus 12 percent; Transcript study reported: Geometry

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75 percent, Algebra 2 58 percent, Trigonometry/Pre-calculus 36 percent, Calculus 18 percent. (We do not compare Algebra 1 because transcript studies generally do not include eighth grade enrollments. State data showed 95+ percent of students taking Algebra 1 by graduation; while the transcript study reported 63 percent.)

Thus, the comparison of rates by the two data collection methods show that transcript data generally produce slightly higher rates of course-taking. One reason for the difference is that CCSSO/state data were reported only during first semester, while the transcript data count all courses taken whether they are year-long, first-semester, or second-semester courses. The transcript study rates have a small standard error (1 percent to 2 percent), while CCSSO estimates from state data include some error introduced by imputation for missing states. The CCSSO data from states could also be compared to student self-report data from NAEP assessments in mathematics and science. However, comparisons of self-reported vs. transcript data show that self-report data often have slightly inflated rates of course-taking.

Variability is added to the state estimates through the weighted student membership based on regional weights. Since the weights are not state specific, each estimate has variability. For this reason, estimates over 95 percent of students cannot be made with precision; and enrollments at this level are shown as 95+ percent.

Course enrollment rates are based on enrollment as of fall 1999. Some states collect data on student course taking for fall and spring semesters. The state comparisons are based on cross-sectional data collected as of October 1. The indicator does not account for course-taking in spring semester courses.

Imputation of estimated proportion of high school graduates taking selected mathematics and science courses for nonreporting states. In 1999–00, 33 states were able to report course enrollment data to CCSSO. To obtain a national total for the estimated proportion of graduates taking selected mathematics and science courses, the state proportions were imputed. The following formula was used for imputation:

Estimated proportion of students taking Biology 1 in nonreporting state B = [Reg. avg. % taking Biology 1 (9-12) x state B student membership (9-12)] / Sum of estimated numbers of students in cohort in grades 9-12 *(from CCD and regional weights based on NAEP transcript study) (as above)*

Where Reg. avg. % taking Biology 1 is the average (mean) percent of students taking Biology 1 among the reporting states in state B's region

Imputation of number of teachers per field (in mathematics, biology, chemistry, etc.) for nonreporting states.

Imputed number of teacher of mathematics in state C = State student membership (9-12) / Regional ratio students/teacher * Regional ratio of mathematics teachers to total teachers (9-12)

Regional ratio students/teacher = State student membership (9-12) / State total teachers (9-12) — Average for states in region

Regional ratio mathematics teachers to total teachers = State mathematics teachers (9-12) / State total teachers (9-12) — Average for states in region

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TABLE A-1 Public School Student Membership, by Grade and State: Fall 1998

STATE	Grades 7-8	Grades 9-12
Alabama	115,786	205,630
Alaska	21,429	38,394
Arizona	130,591	224,867
Arkansas	71,506	132,507
California	855,771	1,627,284
Colorado	108,145	197,136
Connecticut	82,091	145,317
Delaware	18,286	33,307
District of Columbia	8,640	13,932
DoDEA	10,836	14,961
Florida	363,042	633,609
Georgia	211,720	371,905
Hawaii	26,949	53,338
Idaho	37,531	76,118
Illinois	297,509	558,505
Indiana	149,661	289,027
Iowa	75,903	155,834
Kansas	74,065	142,094
Kentucky	98,197	188,371
Louisiana	117,623	205,393
Maine	34,840	58,947
Maryland	125,553	231,534
Massachusetts	145,249	257,693
Michigan	247,917	448,867
Minnesota	135,298	269,566
Mississippi	76,744	130,815
Missouri	140,219	259,308
Montana	25,978	50,348
Nebraska	45,092	91,386
Nevada	46,984	81,767
New Hampshire	33,613	57,924
New Jersey	174,619	307,945
New Mexico	51,476	96,268
New York	404,702	774,469
North Carolina	192,362	333,983
North Dakota	18,318	37,737
Ohio	284,688	541,121
Oklahoma	95,773	179,642
Oregon	85,423	162,272
Pennsylvania	281,387	535,400
Puerto Rico	97,478	157,385
Rhode Island	23,149	42,113
South Carolina	104,984	186,742
South Dakota	21,559	41,546
Tennessee	135,152	240,872
Texas	603,681	1,077,158
Utah	70,710	147,857
Vermont	16,390	31,522
Virgin Islands	3,582	5,703
Virginia	170,323	308,627
Washington	155,341	302,103
West Virginia	45,620	91,413
Wisconsin	136,482	278,839
Wyoming	15,745	31,292

SOURCE: NCES, Common Core of Data, Fall 1998.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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TABLE A-2 Percent of Public School Students by Race/Ethnicity, by State, 1998-99

STATE	White	Black	Hispanic	Asian	American Indian	Total Minority
Alabama	61.5	36.2	0.9	0.7	0.7	38.5
Alaska	62.5	4.6	3.0	5.1	24.8	37.5
Arizona	55.0	4.5	31.7	1.9	6.9	45.0
Arkansas	72.8	23.5	2.5	0.8	0.4	27.2
California	37.9	8.7	41.4	11.1	0.9	62.1
Colorado	70.6	5.6	19.9	2.7	1.2	29.4
Connecticut	71.2	13.6	12.4	2.6	0.3	28.8
Delaware	62.4	30.4	4.9	2.0	0.2	37.6
District of Columbia	4.3	85.9	8.3	1.6	*	95.7
Florida	55.3	25.5	17.2	1.8	0.3	44.7
Georgia	56.4	38.1	3.4	2.0	0.1	43.6
Hawaii	20.8	2.4	4.6	71.7	0.4	79.2
Idaho	87.1	0.7	9.7	1.2	1.2	12.9
Illinois	61.4	21.4	13.9	3.2	0.2	38.6
Indiana	84.7	11.4	2.8	0.9	0.2	15.3
Iowa	91.4	3.6	2.8	1.7	0.5	8.6
Kansas	80.6	8.6	7.5	2.1	1.2	19.4
Kentucky	88.4	10.4	0.7	0.4	0.1	11.6
Louisiana	49.7	47.1	1.3	1.3	0.7	50.3
Maine	97.0	1.1	0.5	0.9	0.5	3.0
Maryland	55.0	36.6	4.0	4.0	0.3	45.0
Massachusetts	77.1	8.6	10.0	4.2	0.2	22.9
Michigan	74.7	19.5	3.0	1.7	1.0	25.3
Minnesota	85.6	5.6	2.5	4.4	2.0	14.4
Mississippi	47.7	51.0	0.5	0.6	0.1	52.3
Missouri	80.2	17.0	1.4	1.1	0.3	19.8
Montana	86.8	0.5	1.6	0.8	10.2	13.2
Nebraska	84.8	6.3	5.9	1.4	1.5	15.2
Nevada	61.2	9.9	22.0	5.1	1.8	38.8
New Hampshire	96.2	1.0	1.4	1.2	0.2	3.8
New Jersey	61.6	18.1	14.3	5.8	0.2	38.4
New Mexico	37.2	2.3	48.8	1.0	10.8	62.8
New York	55.6	20.4	18.1	5.6	0.4	44.4
North Carolina	62.5	31.2	3.1	1.7	1.5	37.5
North Dakota	89.9	1.0	1.2	0.7	7.3	10.1
Ohio	81.5	15.8	1.5	1.1	0.1	18.5
Oklahoma	67.0	10.7	4.9	1.4	16.0	33.0
Oregon	82.9	2.7	8.7	3.7	2.1	17.1
Pennsylvania	79.4	14.6	4.0	1.9	0.1	20.6
Rhode Island	76.4	7.6	12.3	3.3	0.5	23.6
South Carolina	55.7	42.0	1.2	0.9	0.2	44.3
South Dakota	87.5	1.0	1.0	0.9	9.6	12.5
Tennessee	73.6	23.9	1.2	1.1	0.1	26.4
Texas	44.1	14.4	38.6	2.5	0.3	55.9
Utah	87.9	0.8	7.2	2.5	1.5	12.1
Vermont	97.1	0.9	0.4	1.0	0.5	2.9
Virginia	64.9	27.2	3.9	3.7	0.2	35.1
Washington	76.1	5.1	9.1	7.1	2.6	23.9
West Virginia	94.9	4.2	0.5	0.3	0.1	5.1
Wisconsin	81.9	9.8	3.8	3.1	1.4	18.1
Wyoming	88.6	1.0	6.7	0.8	2.9	11.4
American Samoa	–	–	–	100.0	–	100.0
Guam	2.2	0.4	0.2	97.1	0.1	97.8
Northern Marianas	0.8	–	–	99.2	–	99.2
Puerto Rico	–	–	100.0	–	–	100.0
Virgin Islands	0.9	84.7	13.9	0.4	0.1	99.1
NATION	**62.9**	**17.1**	**15.0**	**3.9**	**1.1**	**37.1**

NOTE: * Less than 0.05 percent.

SOURCE: NCES, Common Core of Data, Fall 1998.

Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 2001.

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Appendix B

Directory of State Course Titles by Reporting Categories

State Science and Mathematics Indicators (Fall 1999)
CCSSO INDICATORS

Science Course Categories

State Course Titles (from state data forms)

Grades 7-8

General Science, 7-8
General Science 7, 8

Life Science, 7-8
Life Science 7, 8

Earth Science, 7-8
Earth Science 7, 8

Physical Science, 7-8
Physical Science 7, 8

Integrated/Coordinated Science, 7-8
Science I, II; SS&C; Project 2061; Integrated Science 7, 8; Earth/Life/Physical Science 7, 8; Coordinated Science 7, 8

Other Science, 7-8
Other science courses for grades 7 or 8 listed under the "Science" category on state data collection form.

Grades 9-12

Biology, 1st Year
Biology I; General; College Prep.; Regents; Introductory; BSCS I

Biology, 1st Year, Applied
Basic Biology; Applied; Life Science; Biomedical Ed.; Animal Science; Horticulture Sci.; Bio. Science; Health Science; Nutrition; Man & Disease; Agricul. Science; Fundamentals of Biology

Biology, 2nd Year, Advanced Placement
Advanced Placement Biology

Biology, 2nd Year, Advanced
Biology II; Advanced; College; Psychobiology; Physiology; Anatomy; Microbiology; Genetics; Cell Biology; Embryology; Molecular Biology; Invertebrate/Vertebrate Biology; BSCS II

Biology, 2nd Year, Other
Zoology; Botany; Biomedical careers; Field Biology; Ecology; Marine Biology; Other Biological Sciences

Chemistry, 1st Year
Chemistry I; General; Introductory; Regents

Chemistry, 1st Year, Applied
Applied Chemistry; Consumer Chemistry; Technical Chemistry; Practical Chemistry; Chemistry in the Community

Chemistry, 2nd Year, Advanced Placement
Advanced Placement Chemistry

Chemistry, 2nd Year, Advanced
Chemistry II; Advanced; College; Organic; Inorganic; Physical; Biochemistry; Analytical

Physics, 1st Year
Physics I; General; Regents; Introductory

Physics, 1st Year, Applied
Applied Physics; Electronics; Radiation Physics; Practical Physics; Applied/Conceptual Physics; Electricity

Physics, 2nd Year, Advanced Placement
Advanced Placement Physics

Physics, 2nd Year, Advanced
Physics II; Advanced; College; Nuclear Physics; Atomic Physics

Earth Science, 1st Year
Earth Science; Earth-Space Science; Regents Earth Science; Space Science; Aerospace Science (courses that are generally taught at grade 9 and at introductory level)

Earth Science, 1st Year, Applied
Applied Earth Science; Fundamentals of Earth Science; Soil Science

Earth Science, 2nd Year, Advanced/Other
Advanced Earth Science; Earth Science II; Oceanography; Aquatic Science; Marine Science; Astronomy; Geology; Meteorology (courses that are generally taught at grade 10, 11, or 12 and at higher level than Earth Science, 1st Year)

General Science
General Science; Basic; Introductory; Consumer Science

Physical Science
Physical Science; Interaction of Matter and Energy; Applied Physical Science

Integrated/Coordinated Science
Science III, IV; SS&C; Project 2061; Integrated Science 9, 10; Unified; Comprehensive Ideas of Investigations in Science; Life/Physical Science; Earth/Life/Physical Science; Coordinated Science

Environmental Science
Environmental Science; Environmental Education

Technology (taught as science course)
Principles of Technology I, II; Science/Technology/Society; Tech. Prep. Science; Biotechnology; Histologic Technology

Other Science
Science/Math; Engineering; Bioengineering; Special Interests Science; Energy; Research Topics; Laboratory Management; Aviation; Other science courses for grades 9-12 listed under the "Science" category on state data collection form.

Mathematics Course Categories

- State Course Titles (from state data forms)

Grades 7-8

Remedial Math, Grade 7
Remedial Math 7

Math, Grade 7, Regular
Math 7; Math Grade 7 Regular

Math, Grade 7, Accelerated
Accelerated Math 7; Pre-algebra; Honors Math 7; Enriched Math 7

Remedial Math, Grade 8
Remedial Math 8

Math, Grade 8, Regular
Math 8; Math Grade 8 Regular

Math, Grade 8, Accelerated
Accelerated Math 8; Pre-algebra; Honors Math 8; Enriched Math 8

Math, Grades 7-8, Algebra 1
Algebra 1; Beginning Algebra; Elementary Algebra

Integrated Middle Grades Math, Grades 7-8
Integrated Math 7 or 8; Connected Math 7 or 8

Grades 9-12

Review Mathematics

Level 1
General Math 1; Basic Math; Math 9; Remedial Math; Developmental; H.S. Arithmetic; Math Comp Test; Comprehensive Math; Terminal Math

Level 2
General Math 2; Vocational Math; Consumer; Technical; Business; Shop; Math 10; Career Math; Practical Math; Essential Math; Cultural Math

Level 3
General Math 3; Math 11; Intermediate Math

Level 4
General Math 4; Math 12; Mathematics of Consumer Economics

Informal Mathematics

Level 1
Pre-algebra; Introductory Algebra; Basic; Applications; Algebra 1A (first year of two-year sequence for Algebra 1); Math A; Applied Math 1

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Level 2
Basic Geometry; Informal Geometry; Practical Geometry; Applied Math 2

Level 3
Applied Math 3, 4

Formal Mathematics

Level 1
Algebra 1; Elementary; Beginning; Unified Math I; Integrated Math 1; Algebra 1B (second year of two-year sequence for Algebra 1); Math B

Level 2
Geometry; Plane Geometry; Solid Geometry; Integrated Math 2; Unified Math II; Math C

Level 3
Algebra 2; Intermediate Algebra; Algebra and Trigonometry; Advanced Algebra; Algebra and Analytic Geometry; Integrated Math 3; Unified Math III

Level 4
Trigonometry; College Algebra; Algebra 3; Pre-calculus; Analytic/Advanced Geometry; Trigonometry and Analytic/Solid Geometry; Advanced Math Topics; Intro. to College Math; Number Theory; Math IV; College Prep Sr. Math; Elem. Functions; Finite Math; Math Analysis; Numerical Analysis; Discrete Math; Probability; Statistics

Level 5
Calculus and Analytic Geometry; Calculus; Abstract Algebra; Differential Equations; Multivariate Calculus; Linear Algebra; Theory of Equations; Vectors/Matrix Algebra

Level 5, Advanced Placement
Advanced Placement Calculus (AB, BC); Advanced Placement Statistics

Other Mathematics, 9-12
Used only if state has a code for "Other Mathematics."

Computer Science Course Categories

State Course Titles (from state data forms)

Grades 7-8

Computer Science/Computer Programming
Introductory Programming (any language)

Grades 9-12

Computer Science/Programming I
Introductory Programming (any language); Programming I; Computer Language I

Advanced Computer Science/Programming II
Advanced Programming; Programming II; Computer Language II

Computer Science, Advanced Placement
Advanced Placement Computer Science

SOURCE: Instructions and Reporting Forms for Data on Science and Mathematics Education in (each state). *Council of Chief State School Officers, State Education Assessment Center, Washington, DC, Fall 1999.*

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